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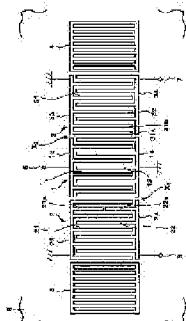
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(54) SURFACE ACOUSTIC WAVE INSTRUMENT AND COMMUNICATION SYSTEM



(57) Abstract:

PROBLEM TO BE SOLVED: To provide an surface acoustic wave instrument

having improved balancing property which has a function of conversion between a balanced type and an unbalanced type, and a communication instrument using it.

SOLUTION: A plurality of interdigital electrodes 1, 2, and 3 which have a plurality of electrode fingers are provided, in the direction of propagation of elastic surface waves, on a piezoelectric substrate 8 so that they may form a longitudinally-coupled resonator. Some of the interdigital electrodes 1, 2, and 3 are for balancing and an inner electrode finger 22 different from outer most electrode fingers 21 and 22 of at least one of balance side is provided with a weighted electrode finger 22a.

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## CLAIMS

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[Claim(s)]

[Claim 1]

On a piezo-electric substrate, the comb mold polar zone for an input which has two or more electrode fingers, and the comb mold polar zone for an output which has two or more electrode fingers are prepared along the propagation direction of a surface acoustic wave so that a vertical joint resonator mold may be formed,

Either said comb mold polar zone for an input or the comb mold polar zone for an output is surface acoustic wave equipment characterized by having the weighting electrode finger by which weighting was carried out to an inside electrode finger which is an object for a balance and is different from the outermost electrode finger of one [ at least ] electrode finger of each of the balancing side.

[Claim 2]

Said one weighting electrode finger is surface acoustic wave equipment according to claim 1 characterized by going away and being prepared in within the limits from the degree of the outermost electrode finger in the mold polar zone to less than 1/2 of all electrode fingers.

[Claim 3]

Surface acoustic wave equipment according to claim 1 or 2 characterized by forming the ground electrode finger which contains in one [ at least ] electrode finger of each of said comb mold polar zone for an input, and the comb mold polar zone for an output the outermost electrode finger of the location which meets another comb mold polar zone mutually, and which continued two or more.

[Claim 4]

Said weighting electrode finger is surface acoustic wave equipment given in claim 1 characterized by the thing which is an object for a balance about the nothing electric-field section formed while each ground electrode finger which is an electrode finger with which either [ at least ] said comb mold polar zone for an input or the comb mold polar zone for an output was grounded adjoins each other , and which is set up so that two may go away and both mold polar zone may have thru/or any 1 term of 3 .

[Claim 5]

said -- weighting -- an electrode -- a finger -- a balance -- \*\* -- two -- a \*\* -- going away -- \*\* -- a mold -- the polar zone -- respectively -- two -- a \*\* -- more than -- mutual -- having continued -- a ground --

an electrode -- a finger -- from -- becoming ---less -- electric field -- the section -- having -- as -- setting up -- having -- \*\*\* -- things -- the description -- \*\* -- carrying out -- a claim -- one -- or -- three -- some -- one -- a term -- a publication -- a surface acoustic wave -- equipment .

[Claim 6]

Surface acoustic wave equipment according to claim 4 or 5 characterized by the thing which is an object for a balance, and which is set up so that two may go away and the magnitude of said non-electric-field section may become almost the same by the mold polar zone.

[Claim 7]

Said weighting electrode finger is surface acoustic wave equipment given in claim 1 characterized by being set up shorter than other electrode fingers thru/or any 1 term of 6.

[Claim 8]

Surface acoustic wave equipment given in claim 1 characterized by being formed so that the grounded electrode finger for the first balance may be prolonged toward said weighting electrode finger according to the die length of the above-mentioned weighting electrode finger thru/or any 1 term of 7.

[Claim 9]

The grounded electrode finger for the second balance is formed toward a different location from said weighting electrode finger according to the die length of the above-mentioned weighting electrode finger,

Surface acoustic wave equipment given in claim 1 characterized by preparing the dummy electrode formed by bending so that the above-mentioned electrode finger for the second balance and a weighting electrode finger may be met thru/or any 1 term of 8.

[Claim 10]

Surface acoustic wave equipment given in claim 1 characterized by having the unbalance mold-balance type-conversion function thru/or any 1 term of 9.

[Claim 11]

It is surface acoustic wave equipment equipped with at least one, and the input signal terminal and output signal terminal for the above-mentioned surface acoustic wave filter for the surface acoustic wave filter which was formed along the propagation direction of a surface acoustic wave on the piezo-electric substrate, and which goes away at least two and has the mold polar zone,

Either [ at least ] an input signal terminal or an output signal terminal is surface acoustic wave equipment characterized by the thing

in which it connects with the balanced signal terminal, and electrode fingers other than an outermost electrode finger in the above-mentioned comb mold polar zone change the decapsulation width of face of an electrode finger with other electrode fingers, and which is done for decapsulation width-of-face weighting.

[Claim 12]

Said decapsulation width-of-face weighting is surface acoustic wave equipment according to claim 11 characterized by setting up an electrode finger shorter than other electrode fingers, and giving it.

[Claim 13]

Said decapsulation width-of-face weighting is surface acoustic wave equipment according to claim 11 or 12 characterized by being given in the abbreviation center section of the decapsulation direction.

[Claim 14]

Surface acoustic wave equipment given in claim 11 characterized by preparing the dummy electrode in said comb mold polar zone so that the electrode finger by which decapsulation width-of-face weighting was carried out [ above-mentioned ] may be countered thru/or any 1 term of 13.

[Claim 15]

Said dummy electrode is surface acoustic wave equipment according to claim 14 characterized by connecting with a ground.

[Claim 16]

Surface acoustic wave equipment given in claim 1 characterized by giving the above-mentioned comb mold polar zone at least in one side to several electrode fingers from the outermost electrode finger of the part which adjoins each other mutually among the comb mold polar zone which said weighting adjoins mutually [ said surface acoustic wave filter ] thru/or any 1 term of 15.

[Claim 17]

Surface acoustic wave equipment given in claim 1 characterized by giving the above-mentioned comb mold polar zone at least in one side to several electrode fingers located near the outermost electrode finger of the part which adjoins each other mutually among the comb mold polar zone which said weighting adjoins mutually [ said surface acoustic wave filter ] thru/or any 1 term of 15.

[Claim 18]

Surface acoustic wave equipment given in claim 1 characterized by giving the above-mentioned comb mold polar zone at least in one side to the electrode finger of the range from the outermost electrode finger of the part which adjoins each other mutually to less than 1/2 of the

propagation direction of the surface acoustic wave of the above-mentioned comb mold polar zone among the comb mold polar zone which said weighting adjoins mutually [ said surface acoustic wave filter ] thru/or any 1 term of 15.

[Claim 19]

The electrode finger of the part of the comb mold polar zone of said surface acoustic wave filter which adjoins each other mutually which adjoins each other mutually is with a ground electrode finger and a signal electrode finger, respectively,

Surface acoustic wave equipment given in claim 1 characterized by giving said weighting to either [ at least ] the above-mentioned ground electrode finger or a signal electrode finger thru/or any 1 term of 18.

[Claim 20]

Said electrode finger by which weighting is carried out is surface acoustic wave equipment given in claim 1 characterized by being the signal electrode finger of said surface acoustic wave filter thru/or any 1 term of 19.

[Claim 21]

Said weighting is surface acoustic wave equipment given in claim 1 characterized by being given to the electrode finger of the comb mold polar zone connected to the balanced signal terminal of said surface acoustic wave filter thru/or any 1 term of 20.

[Claim 22]

Said at least one surface acoustic wave filter goes away, and otherwise it goes away, and to the mold polar zone, phase inversion is carried out and it has the mold polar zone,

Said weighting is surface acoustic wave equipment given in claim 1 characterized by above-mentioned carrying out phase inversion preparations and being given to the electrode finger of the mold polar zone thru/or any 1 term of 21.

[Claim 23]

It is surface acoustic wave equipment which was formed along the propagation direction of a surface acoustic wave on the piezo-electric substrate and which is equipped with at least one, and the input signal terminal and output signal terminal for the above-mentioned surface acoustic wave filter for the surface acoustic wave filter which adjoins each other mutually, respectively, and which goes away at least three and has the mold polar zone,

Either [ at least ] the input signal terminal or the output signal terminal is connected to the balanced signal terminal,

At least in one side of the comb mold polar zone which adjoins each

other mutually, duty weighting which changes duty of the outermost electrode finger of the part where the above-mentioned comb mold polar zone adjoins each other mutually with other electrode fingers is given, And it is while the above-mentioned comb mold polar zone thins out and weighting is carried out to the outermost electrode finger of the part which adjoins each other mutually at least in one side of different comb mold polar zone which adjoins each other mutually,

Surface acoustic wave equipment characterized by preparing the dummy electrode connected to the bus bar to which the electrode finger by which infanticide weighting was carried out [ above-mentioned ] was connected, and the opposite bus bar which counters in the part by which infanticide weighting was carried out [ above-mentioned ].

[Claim 24]

Said surface acoustic wave filter is surface acoustic wave equipment given in claim 1 characterized by being prepared so that it may have balanced signal input-balance signal output filter ability thru/or any 1 term of 23.

[Claim 25]

Said surface acoustic wave filter is surface acoustic wave equipment given in claim 1 characterized by being prepared so that it may have balanced signal input-unbalance signal output filter ability or unbalance signal input-balance signal output filter ability thru/or any 1 term of 23.

[Claim 26]

At least one of said the comb mold polar zone is surface acoustic wave equipment according to claim 24 or 25 characterized by carrying out 2 \*\*\*\*s crosswise [ decussation ].

[Claim 27]

Surface acoustic wave equipment given in claim 24 characterized by for one balanced signal terminal used as the aforementioned pair going away, and connecting it to the sinking comb-like electrode of the two poles in the mold polar zone, respectively thru/or any 1 term of 26.

[Claim 28]

At least one of said the comb mold polar zone is surface acoustic wave equipment according to claim 24 or 25 characterized by carrying out 2 \*\*\*\*s in the propagation direction of a surface acoustic wave.

[Claim 29]

Surface acoustic wave equipment given in claim 24 characterized by not having the grounded electrical neutrality point between the balanced signal terminals used as the aforementioned pair thru/or any 1 term of 29.

[Claim 30]

Surface acoustic wave equipment given in claim 1 characterized by preparing said surface acoustic wave filter so that it may have balanced signal input-balance signal output filter ability by two thru/or any 1 term of 23.

[Claim 31]

Said surface acoustic wave filter is prepared so that the phase of the output signal over two and an input signal may be changed about 180 degrees,

Each above-mentioned \*\*\*\*\* filter is surface acoustic wave equipment given in claim 1 characterized by being prepared so that it may have balanced signal input-unbalance signal output filter ability or unbalance signal input-balance signal output filter ability thru/or any 1 term of 23.

[Claim 32]

Surface acoustic wave equipment according to claim 31 characterized by carrying out cascade connection of the surface acoustic wave filter to the unbalance signal terminal side further.

[Claim 33]

Said surface acoustic wave filter is surface acoustic wave equipment given in claim 1 characterized by being a vertical joint resonator mold surface acoustic wave filter thru/or any 1 term of 32.

[Claim 34]

Said odd vertical joint resonator mold surface acoustic wave filters are surface acoustic wave equipment according to claim 33 characterized by going away and having the mold polar zone.

[Claim 35]

Said three vertical joint resonator mold surface acoustic wave filters are surface acoustic wave equipment according to claim 34 characterized by going away and having the mold polar zone.

[Claim 36]

Said at least one vertical joint resonator mold surface acoustic wave filter is surface acoustic wave equipment given in claim 33 which goes away and is characterized by the total electrode finger number of the mold polar zone being even thru/or any 1 term of 35.

[Claim 37]

Three or more vertical joint resonator mold surface acoustic wave filters are surface acoustic wave equipment according to claim 36 characterized by the total number of the electrode finger of the comb mold polar zone which goes away and is connected to the balanced signal terminal at least among mold polar zone being even.

[Claim 38]

Three or more vertical joint resonator mold surface acoustic wave filters are surface acoustic wave equipment according to claim 36 or 37 characterized by the total number of the electrode finger of the comb mold polar zone which goes away and is located in a center section at least among mold polar zone being even.

[Claim 39]

Surface acoustic wave equipment given in claim 1 characterized by connecting at least one surface acoustic wave resonator to said surface acoustic wave filter by either [ at least ] the serial or juxtaposition thru/or any 1 term of 38.

[Claim 40]

Said surface acoustic wave filter is surface acoustic wave equipment given in claim 1 characterized by carrying out cascade connection of the two or more elastic filter sections thru/or any 1 term of 39.

[Claim 41]

The communication device characterized by using the surface acoustic wave equipment of a publication for claim 1 thru/or any 1 term of 40.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention relates to the surface acoustic wave equipment used for the filter which has an unbalance mold-balance type-conversion function, and the communication device using it.

[0002]

[Description of the Prior Art]

In recent years, the technical progress over the miniaturization of communication devices, such as a portable telephone, and lightweighting has a remarkable thing. As a filter used for such a communication device, the surface acoustic wave equipment which can be miniaturized is used as a use frequency band becomes high. Furthermore, the development of the components which compounded two or more functions for reduction of each number of component parts and a miniaturization in a communication device has also progressed.

[0003]

Against the background of such a situation, what equipped with balanced – unbalance conversion function and the function of the so-called balun (balun) the surface acoustic wave filter used for RF stage of a portable telephone is studied briskly in recent years, and has come to be used focusing on GSM (Global System for Mobile communications) etc. It applies also for some patents about the surface acoustic wave filter equipped with such a balanced – unbalance conversion function.

[0004]

As a surface acoustic wave filter which has balanced – unbalance conversion function that an input impedance and an output impedance are almost equal, the configuration as shown in drawing 67 is known.

[0005]

Surface acoustic wave equipment given in drawing 67 is surface acoustic wave equipment of the vertical joint resonator mold of 3IDT type which has balanced – unbalance conversion function in which the comb mold polar zone (it is called IDT Inter-Digital Transducer called blind-like polar zone and the following) 101 is formed on the piezo-electric substrate 100, and IDT102 and IDT103 are arranged at right and left (meeting in the propagation direction of a surface acoustic wave) of the above IDT101, respectively.

[0006]

Further, the reflector (reflector) 104 and the reflector 105 are arranged, respectively, and the terminal 108 is formed in the above-mentioned surface acoustic wave equipment as each terminals 106 and 107 and an unbalance signal terminal as a balanced signal terminal so that each above 102, 101, and IDT 103 may be put from right and left.

[0007]

Moreover, an input impedance and an output impedance are changed 4 times mutually, and the configuration of a publication is mentioned, for example to JP, 10-117123, A as other surface acoustic wave equipments which have balanced – unbalance conversion function.

[0008]

In surface acoustic wave equipment given in the above-mentioned official report, as shown in drawing 68 , the 1st surface acoustic wave filter 111 and the 1st surface acoustic wave filter 111 have the 2nd surface acoustic wave filter 112 with which the phases of an output signal differ 180 degrees on the piezo-electric substrate. In addition, the publication of a piezo-electric substrate is omitted in drawing 68 . Thereby, the above-mentioned surface acoustic wave equipment can demonstrate balanced - unbalance conversion function with a filtering function.

[0009]

the vertical joint resonator mold surface acoustic wave filter 124 of 3IDT type which serves as mirror symmetry on both sides of the symmetry line by which the 1st surface acoustic wave filter 111 met in the propagation direction of a surface acoustic wave to the 3IDT type vertical joint resonator mold surface acoustic wave filter 118 and the vertical joint resonator mold surface acoustic wave filter 118 -- cascade connection -- that is, two-step cascade connection is carried out.

[0010]

the vertical joint resonator mold surface acoustic wave filter 118 -- right and left (meeting in the propagation direction of a surface acoustic wave) of a center of IDT113 -- every -- IDT 114 and 115 is arranged, respectively, and reflectors 116 and 117 are arranged, respectively so that these IDT(s) 114, 113, and 105 may be further put from both sides on either side. Reflectors 122 and 123 are arranged so that the vertical joint resonator mold surface acoustic wave filter 124 may arrange each IDT 120 and 121 to right and left of a center of IDT119 similarly, respectively and may put these IDT(s) 120, 119, and 121.

[0011]

The 2nd surface acoustic wave filter 112 carries out two-step cascade connection of the same vertical joint resonator mold surface acoustic wave filter 128 as the 3IDT type vertical joint resonator mold surface acoustic wave filter 124, and the vertical joint resonator mold surface acoustic wave filter 127 equipped with IDT (that is, about 180 degrees)133 which reversed the central sense of IDT103 and reversed the phase to the 3IDT type vertical joint resonator mold surface acoustic wave filter 118.

[0012]

Each balanced terminals 106 and 107 consist of terminals connected to the unbalance terminal 108 and the serial with the terminal which connected electrically to juxtaposition each terminals 129 and 130 of

the 1st and 2nd surface acoustic wave filter 111 and 112 which are one side, respectively, connected another terminals 131 and 132 of each to the serial electrically, and was connected to juxtaposition.

[0013]

In the surface acoustic wave equipment which has balanced - unbalance conversion function, the amplitude characteristic spreads a phase etc. and it is required for the transmission characteristic in the passband between the unbalance terminal 108 and each terminal of each balanced terminals 106 and 107 that the phase characteristic should be mutually reversed 180 degrees. Those properties are called amplitude unbalance and phase unbalance, respectively.

[0014]

When the surface acoustic wave equipment which has said balanced - unbalance conversion function is considered to be the device of three ports with amplitude unbalance and phase unbalance, for example, each of a port 1 and each balanced output terminal is made into a port 2 and a port 3 for an unbalanced input terminal,

Amplitude unbalance =  $|A|$  and  $A = |20 \log |(S21)| - |20 \log |(S31)||$  -- Formula (1)

Phase unbalance =  $|B|$  and  $B = |**S21 - **S31|$  -- Formula (2)

A definition is come out and given. In addition, S21 shows the transfer factor from a port 1 to a port 2, and S31 shows the transfer factor from a port 1 to a port 3. As for 0dB and phase unbalance, amplitude unbalance is made into 180 degrees in the passband [ in / ideally / in such unbalance / the filter shape of surface acoustic wave equipment ].

[0015]

[Problem(s) to be Solved by the Invention]

However, in the surface acoustic wave equipment which has the above balanced signal terminals, there was a problem that the unbalance between balanced signal terminals was getting worse. A thing of the wavelength it is decided in the pitch of an electrode finger that the distance (110 of drawing 67) of the electrode finger and the signal electrode finger of IDT103 with which some causes that unbalance is bad are connected to the distance (109 of drawing 67) of the electrode finger and the signal electrode finger of IDT102 which are connected to the balanced signal terminal 106 as one of them although mentioned, and the balanced signal terminal 107 will be different 0.5 times is mentioned.

[0016]

the evil in which the conversion efficiency between the electrical signals and surface acoustic waves with which the total capacity of the

electrode finger which each balanced signal terminals 106 and 107 are alike, respectively, and is connected differs by this differs -- generating -- a result -- unbalance -- it had led to aggravation.

[0017]

Then, the amplitude characteristic over the frequency which connects the balanced signal terminal 107 of drawing 67 to a ground, and is outputted from the balanced signal terminal 106 like drawing 70 , and the amplitude characteristic which connects the balanced signal terminal 106 of drawing 67 to a ground, and is outputted from the balanced signal terminal 107 like drawing 71 are measured, and the difference of the above-mentioned amplitude characteristic as those results is shown in drawing 69 . The two amplitude characteristics differ greatly mutually and this difference has led to aggravation of unbalance.

[0018]

moreover -- the surface acoustic wave equipment which was shown in drawing 68 and which carried out cascade connection -- two every which adjoins each other mutually -- the polarity of each two electrode fingers in IDT which meet mutually -- right and left -- it originated in it being in an unsymmetrical condition, and the problem that unbalance gets worse is produced.

[0019]

that is, every which IDT113 adjoins -- every which adjoins each other mutually in IDT 114 and 115 and each part (125 of drawing 68 ) -- every which IDT133 adjoins to both outermost electrode fingers of IDT 113, 114, and 115 being ground electrode fingers -- in each part (126 of drawing 68 ) which adjoins IDT 134 and 135, they are a signal electrode finger and a ground electrode. thus, adjacent every -- if a polar combination in the outermost electrode finger of IDT changes, the frequency and amplitude level of resonance mode which are shown in drawing 72 will change with conversion between an electrical signal and a surface acoustic wave.

[0020]

drawing 68 -- like -- above every which adjoins each other mutually -- the combination of each electrode finger outside \*\* in IDT -- difference -- when surface acoustic wave equipment equipped with balanced - unbalance conversion function was constituted combining the vertical joint resonator mold surface acoustic wave filter whose number is two, the gap of this resonance mode caused unbalance aggravation between balanced signal terminals.

[0021]

The gap of the above-mentioned resonance mode occurred similarly, and

this phenomenon caused unbalance aggravation between balanced signal terminals, when surface acoustic wave equipment equipped with balanced - unbalance conversion function was constituted using one vertical joint resonator mold surface acoustic wave filter as shown in drawing 73 .  
[0022]

The purpose of this invention is correcting the difference between the above-mentioned balanced signal terminals which are the cause of the unbalance aggravation between balanced signal terminals, and is to offer the surface acoustic wave equipment with which the unbalance between balanced signal terminals has good balanced - unbalance conversion function, and the communication device using it.

[0023]

[Means for Solving the Problem]

IDT for an input which has two or more electrode fingers on a piezo-electric substrate in order that the surface acoustic wave equipment of this invention may solve the above technical problem, IDT for an output which has two or more electrode fingers is prepared along the propagation direction of a surface acoustic wave so that a vertical joint resonator mold may be formed. Either said IDT for an input or IDT for an output It is an object for a balance and is characterized by having the weighting electrode finger by which weighting was carried out to a different inside electrode finger from the outermost electrode finger of one [ at least ] electrode finger of each of the balancing side. In the above-mentioned surface acoustic wave equipment, you may have the unbalance mold-balance type-conversion function.

[0024]

Since the balance of each property between an output signal, especially each output signal for a balance (amplitude balance, phase balance, transmission characteristic) can be adjusted to one [ at least ] electrode finger of each of IDT for an input, and IDT for an output by having formed the weighting electrode finger according to the above-mentioned configuration, the balance nature of each property is improvable.

[0025]

As for said weighting electrode finger, with the above-mentioned surface acoustic wave equipment, it is desirable to be prepared in within the limits from the degree of the outermost electrode finger in one IDT to less than 1/2 of all electrode fingers. As for said weighting electrode finger, in the above-mentioned surface acoustic wave equipment, it is desirable to be set up shorter than other electrode fingers.

[0026]

It is desirable to form the ground electrode finger which contains in one [ at least ] electrode finger of each of said IDT for an input and IDT for an output the outermost electrode finger of the location which meets another IDT mutually with the above-mentioned surface acoustic wave equipment and which continued two or more.

[0027]

According to the above-mentioned configuration, -izing of carrying out a setup of the phase contrast like each output signal for a balance soon at 180 degrees can be carried out [ certain ] by the simple configuration by forming the ground electrode finger containing the outermost electrode finger of the location which meets one electrode finger of each mutually which continued two or more.

[0028]

As for said weighting electrode finger, in the above-mentioned surface acoustic wave equipment, it is desirable to be set up so that both two IDT(s) for a balance may have the non-electric-field section formed while each ground electrode finger which is an electrode finger with which either [ at least ] said IDT for an input or IDT for an output was grounded adjoins each other.

[0029]

With the above-mentioned surface acoustic wave equipment, said weighting electrode finger may be set up so that it may have the non-electric-field section which consists of a ground electrode finger which followed two IDT(s) for a balance mutually two or more, respectively.

[0030]

In the above-mentioned surface acoustic wave equipment, it is two IDT(s) for a balance and it is desirable to be set up so that the magnitude of said non-electric-field section may become almost the same.

[0031]

According to the above-mentioned configuration, it is control and two more desirable IDT(s) for a balance about the magnitude of the non-electric-field section in a weighting electrode finger, and since the balance of the conversion to electrical energy from the elastic strain energy in each IDT, especially IDT for an output can be adjusted by setting up the magnitude of said non-electric-field section so that it may become almost the same, balance nature can be improved.

[0032]

In the above-mentioned surface acoustic wave equipment, it is desirable to be formed so that the grounded electrode finger for the first balance may be prolonged toward said weighting electrode finger according to the die length of the above-mentioned weighting electrode finger.

[0033]

According to the above-mentioned configuration, since the amount of [ which is formed with the weighting electrode finger set up short ] non-electrode finger part can cover to some extent with the electrode finger for the first balance, it can avoid degradation of the balance nature by part for the above-mentioned radio pole finger part.

[0034]

With the above-mentioned surface acoustic wave equipment, the dummy electrode which the grounded electrode finger for the second balance is formed toward a different location from said weighting electrode finger according to the die length of the above-mentioned weighting electrode finger, and is formed by bending so that the above-mentioned electrode finger for the second balance and a weighting electrode finger may be met may be prepared.

[0035]

According to the above-mentioned configuration, a transmission characteristic can be improved further, maintaining good balance nature by preparing a dummy electrode.

[0036]

In order that other surface acoustic wave equipments of this invention may solve the aforementioned technical problem, the surface acoustic wave filter which has at least two IDT(s) formed along the propagation direction of a surface acoustic wave on the piezo-electric substrate At least one It is surface acoustic wave equipment equipped with the input signal terminal and output signal terminal for the above-mentioned surface acoustic wave filter. Either [ at least ] the input signal terminal or the output signal terminal is connected to the balanced signal terminal, and electrode fingers other than an outermost electrode finger in Above IDT are characterized by the thing which change the decussation width of face of an electrode finger with other electrode fingers and which is done for decussation width-of-face weighting.

[0037]

As for said decussation width-of-face weighting, with the above-mentioned surface acoustic wave equipment, it is desirable that an electrode finger is set up shorter than other electrode fingers, and is given. Said decussation width-of-face weighting may be given in the abbreviation center section of the decussation direction. The dummy electrode may be prepared in said IDT so that the electrode finger by which decussation width-of-face weighting was carried out [ above-mentioned ] may be countered. The above-mentioned dummy electrode may be connected to the ground.

[0038]

according to the above-mentioned configuration, electrode fingers other than an outermost electrode finger in Above IDT change the decussation width of face of an electrode finger with other electrode fingers -- since decussation width-of-face weighting is carried out and the balance of each property between an output signal, especially each output signal for a balance (amplitude balance, phase balance, transmission characteristic) can be adjusted, the balance nature of each property is improvable.

[0039]

In the above-mentioned surface acoustic wave equipment, it may be given to several electrode fingers from the outermost electrode finger of the part where Above IDT adjoins each other mutually at least in one side among IDT(s) which said weighting adjoins mutually [ said surface acoustic wave filter ].

[0040]

With the above-mentioned surface acoustic wave equipment, it may be given to several electrode fingers located near the outermost electrode finger of the part where Above IDT adjoins each other mutually at least in one side among IDT(s) which said weighting adjoins mutually [ said surface acoustic wave filter ].

[0041]

In the above-mentioned surface acoustic wave equipment, it may be given to the electrode finger of the range from the outermost electrode finger of the part where Above IDT adjoins each other mutually to less than 1/2 of the propagation direction of the surface acoustic wave of Above IDT at least in one side among IDT(s) which said weighting adjoins mutually [ said surface acoustic wave filter ].

[0042]

With the above-mentioned surface acoustic wave equipment, the electrode finger of the part of IDT which adjoins each other mutually [ said surface acoustic wave filter ] which adjoins each other mutually is with a ground electrode finger and a signal electrode finger, respectively, and said weighting may be given to at least the above-mentioned ground electrode finger or the signal electrode finger either.

[0043]

In the above-mentioned surface acoustic wave equipment, said electrode finger by which weighting is carried out may be a signal electrode finger of said surface acoustic wave filter.

[0044]

Said weighting may be given to the electrode finger of IDT connected to

the balanced signal terminal of said surface acoustic wave filter with the above-mentioned surface acoustic wave equipment.

[0045]

In the above-mentioned surface acoustic wave equipment, to other IDT(s), phase inversion of said surface acoustic wave filter is carried out, it has at least one IDT, and said weighting may be given to the electrode finger of IDT which carried out [ above-mentioned ] phase inversion.

[0046]

In order that the surface acoustic wave equipment of further others of this invention may solve the aforementioned technical problem The surface acoustic wave filter which was formed along the propagation direction of a surface acoustic wave on the piezo-electric substrate and which has at least three IDT(s) which adjoin each other mutually, respectively At least one It is surface acoustic wave equipment equipped with the input signal terminal and output signal terminal for the above-mentioned surface acoustic wave filter. In at least one side of IDT which either [ at least ] the input signal terminal or the output signal terminal is connected to the balanced signal terminal, and adjoins each other mutually In at least one side of IDT which duty weighting which changes duty of the outermost electrode finger of the part where Above IDT adjoins each other mutually with other electrode fingers is given, and is different and which adjoins each other mutually While Above IDT thins out and weighting is carried out to the outermost electrode finger of the part which adjoins each other mutually, in the part by which infanticide weighting was carried out [ above-mentioned ] It is characterized by preparing the dummy electrode connected to the bus bar to which the electrode finger by which infanticide weighting was carried out [ above-mentioned ] was connected, and the opposite bus bar which counters.

[0047]

With the above-mentioned surface acoustic wave equipment, said surface acoustic wave filter may be prepared so that it may have balanced signal input-balance signal output filter ability.

[0048]

In the above-mentioned surface acoustic wave equipment, said surface acoustic wave filter may be prepared so that it may have balanced signal input-unbalance signal output filter ability or unbalance signal input-balance signal output filter ability.

[0049]

In the above-mentioned surface acoustic wave equipment, at least one of said the IDT(s) may be carried out crosswise [ decussation ] 2 \*\*\*\*s.

[0050]

With the above-mentioned surface acoustic wave equipment, the balanced signal terminal used as the aforementioned pair may be connected to the sinking comb-like electrode of the two poles in one IDT, respectively.

[0051]

In the above-mentioned surface acoustic wave equipment, at least one of said the IDT(s) may be carried out in the propagation direction of a surface acoustic wave 2 \*\*\*\*s.

[0052]

With the above-mentioned surface acoustic wave equipment, you may not have the grounded electrical neutrality point between the balanced signal terminals used as the aforementioned pair.

[0053]

In the above-mentioned surface acoustic wave equipment, said surface acoustic wave filter may be prepared so that it may have balanced signal input-balance signal output filter ability by two.

[0054]

With the above-mentioned surface acoustic wave equipment, said surface acoustic wave filter may be prepared so that the phase of the output signal over two and an input signal may be changed about 180 degrees, and each above-mentioned \*\*\*\*\* filter may be prepared so that it may have balanced signal input-unbalance signal output filter ability or unbalance signal input-balance signal output filter ability.

[0055]

In the above-mentioned surface acoustic wave equipment, cascade connection of the surface acoustic wave filter may be further carried out to the unbalance signal terminal side.

[0056]

With the above-mentioned surface acoustic wave equipment, said surface acoustic wave filter may be a vertical joint resonator mold surface acoustic wave filter.

[0057]

In the above-mentioned surface acoustic wave equipment, said vertical joint resonator mold surface acoustic wave filter may have odd IDT(s).

[0058]

With the above-mentioned surface acoustic wave equipment, said vertical joint resonator mold surface acoustic wave filter may have three IDT(s).

[0059]

In the above-mentioned surface acoustic wave equipment, the total electrode finger number of at least one IDT of said vertical joint resonator mold surface acoustic wave filter may be even.

[0060]

With the above-mentioned surface acoustic wave equipment, the total number of the electrode finger of IDT with which the vertical joint resonator mold surface acoustic wave filter is connected to the balanced signal terminal at least among three or three IDT(s) or more may be even.

[0061]

In the above-mentioned surface acoustic wave equipment, the total number of the electrode finger of IDT with which a vertical joint resonator mold surface acoustic wave filter is located in a center section at least among three or three IDT(s) or more may be even.

[0062]

With the above-mentioned surface acoustic wave equipment, at least one surface acoustic wave resonator may be connected to said surface acoustic wave filter by either [ at least ] the serial or juxtaposition.

[0063]

In the above-mentioned surface acoustic wave equipment, said surface acoustic wave filter may carry out cascade connection of the two or more surface acoustic wave filter sections.

[0064]

The communication device of this invention is characterized by using surface acoustic wave equipment given in above any they are, in order to solve the aforementioned technical problem. Since surface acoustic wave equipment equipped with the outstanding balance nature was used according to the above-mentioned configuration, the communication link engine performance can be improved.

[0065]

[Embodiment of the Invention]

It will be as follows if each gestalt of operation of this invention is explained based on drawing 1 thru/or drawing 65 .

[0066]

(The first gestalt of operation)

every for an output which the surface acoustic wave equipment concerning the first gestalt of operation of this invention have an unbalance mold-balance type conversion function and a filtering function as show in drawing 1 , and have be arrange with IDT1 for an input at the both sides ( meeting in the propagation direction of a surface acoustic wave), respectively -- it have IDT 2 and 3 and each reflector 4 arrange further on those outsides, respectively on the piezo-electric substrate 8. In addition, an above-mentioned input and an above-mentioned output can be replaced mutually.

[0067]

that is, every for an output -- IDT 2 and 3 is arranged so that IDT1 for an input may be inserted among them. Furthermore, each reflector 4 is arranged so that IDT2, IDT1, and IDT3 may be inserted among them, and it reflects the surface acoustic wave to spread. The above-mentioned piezo-electric substrate 8 consists of 40 \*\*5-degreeYcutX propagation LiTa03. [0068]

IDT 1, 2, and 3 is equipped with two or more two electrode finger parts equipped with each band-like electrode finger [ that it is parallel and regular intervals ] of each other prolonged in the direction which intersects perpendicularly from the band-like end face section (bus bar) and one flank of the end face section, and has each above-mentioned electrode finger part in the condition of having become intricate between mutual electrode fingers so that the flank of the electrode finger of each above-mentioned electrode finger part might be met mutually.

[0069]

In such IDT 1, 2, and 3, a signal transformation property and a setup of a passband are possible by setting up the decussation width of face which shows the die length and width of face of each electrode finger, spacing of each adjacent electrode finger, and the confrontation die length in the condition between mutual electrode fingers of having become intricate, respectively. With the first gestalt of this operation, the number of the electrode finger of IDT1 is set to 39, and the number of the electrode finger of IDT 2 and 3 is set to 23.

[0070]

Moreover, each above-mentioned electrode finger and an above-mentioned bus bar, and each reflector 4 were formed on the piezo-electric substrate 8 by the photolithography method etc., for example, are formed with the aluminum (aluminum) electrode (foil).

[0071]

And in the first gestalt of this operation, since an unbalance mold signal is inputted and a balanced type signal is outputted, in IDT1 for an input, it is prepared in the condition of having become intricate mutually as each signal electrode finger 11 connected to the input terminal 5 for unbalance and each grounded ground electrode finger 12 mentioned above.

[0072]

Moreover, in the above IDT1, the ground electrode finger 12 is set up so that the outermost electrode finger in the both ends in the propagation direction of a surface acoustic wave may turn into a ground electrode finger, respectively. The above-mentioned outermost electrode finger is

in the location which meets one side of each electrode finger outside \*\* of IDT 2 and 3, respectively.

[0073]

It is prepared in the condition of having become intricate mutually as each ground electrode finger 21 and the signal electrode finger 22 connected to the output terminal 6 for a balance mentioned above in IDT2 on the other hand. Moreover, the bus bar 23 connected with each ground electrode finger 21 is arranged so that it may become straight line-like mostly to the bus bar 13 connected with each signal electrode finger 11 of IDT1 for an input. Moreover, in IDT2, each electrode finger outside \*\* used as each electrode finger of the both ends in the propagation direction of a surface acoustic wave is the ground electrode finger 21, respectively.

[0074]

At IDT3, it is prepared in the condition which each ground electrode finger 31 and the signal electrode finger 32 connected to the output terminal 7 for a balance mentioned above of having become intricate mutually. The bus bar 33 connected with each ground electrode finger 31 is arranged so that it may become straight line-like mostly to the bus bar 13 connected with each signal electrode finger 11 of IDT1 for an input.

[0075]

Moreover, the bus bar 14 of each ground electrode finger 12 of IDT1 is set up so that it may become straight line-like, respectively about the bus bar 24 of each signal electrode finger 22 of IDT2, and the bus bar 34 of each signal electrode finger 32 of IDT3.

[0076]

Furthermore, with the first gestalt of this operation, on structure, it is mutually reversed and each IDT 2 and 3 for an output is formed. That is, in IDT2, while it starts from a ground electrode finger and is set up a signal electrode finger, a ground electrode finger, and by turns from the direction near IDT1, by IDT3, it starts from a signal electrode finger and is considering as the ground electrode finger and the signal electrode finger by being set up by turns from the direction near IDT1.

[0077]

Since it is set up in the first gestalt of this operation by this so that the amplitude difference between each IDT2 and 3 may become [ 0 and phase contrast ] close to 180 degrees, balanced - unbalance conversion function can be demonstrated.

[0078]

And with the first gestalt of this operation, in the part where IDT1 and

IDT3 adjoin each other, the outermost electrode finger of IDT3 thins out and weighting is carried out. Grounded dummy electrode 31a is formed in the location of the electrode finger by which infanticide weighting was carried out. Thereby, at IDT3 used as near between IDT1 and IDT3, a ground electrode finger is located in a line by 2 continuation like dummy electrode 31a and ground electrode finger 31b.

[0079]

Furthermore, with the first gestalt of this operation, decussation weighting electrode finger 22a was set as the location of the signal electrode finger 22 which serves as a degree of the ground electrode finger 21 of the side (outermost electrode finger) near IDT1 for an input among the signal electrode fingers 22 in IDT2 for an output. In above-mentioned decussation weighting electrode finger 22a, it is set up so that the die length of decussation weighting electrode finger 22a may become with [ which adjusted abbreviation one half, i.e., decussation width of face, ] decussation weight as opposed to the die length of other signal electrode fingers 22.

[0080]

Band-like dummy electrode (electrode finger for first balance) 21a which is prolonged from the bus bar 23 grounded and which is an offset electrode finger is formed so that the space produced by weighting electrode finger 22a moreover set up short may be filled. Dummy electrode 21a is prolonged toward the point of decussation weighting electrode finger 22a regular intervals and almost in parallel to each ground electrode finger 21 which adjoins each other mutually.

[0081]

Next, each outline block diagram of IDT of the surface acoustic wave equipment which has balanced - unbalance conversion function of the example of the first comparison explaining an operation and effectiveness of the first gestalt of this operation in which above-mentioned infanticide weighting and above-mentioned decussation weighting are not probably performed to drawing 2 as a comparison is shown. With the configuration of the example of the first comparison, the signal electrode and the ground electrode were located in a line between IDT1 and IDT41 to ground electrodes being located in a line with the adjacent part of IDT1 and IDT40. Therefore, between IDT1 and IDT40, conversion between an electrical signal (signal) and a surface acoustic wave is performed between IDT1 and IDT41 to the non-electric-field section 9 in which conversion of the electrical and electric equipment and a surface acoustic wave is not performed existing. Therefore, the frequency and amplitude level of a signal which are outputted from the

balanced signal terminals 6 and 7 differed from each other, further, a phase was not reversed 180 degrees completely, either but the unbalance between a result and a balanced signal terminal was getting worse.

[0082]

With the first gestalt of this operation, as shown in drawing 3 , IDT1 and IDT41 with which the signal electrode shown in the example of the first comparison and the ground electrode were first located in a line carried out infanticide weighting of the electrode finger of the part which adjoins each other mutually, thinned it out further, and they formed dummy electrode 31a in the location of the electrode finger by which weighting was carried out. That is, it was made for two ground electrode fingers to be located in a line with IDT3 of near between IDT1 and IDT3. Thereby, the difference of the conversion efficiency between the electrical signal between IDT1 and IDT3 and between IDT1 and IDT40 and a surface acoustic wave is corrected, and the balanced signal terminal 6 and the surface acoustic wave equipment with which the unbalance between seven has been improved are obtained.

[0083]

Furthermore, by forming dummy electrode 31a, the increment in loss by a surface acoustic wave being changed into a bulk wave is prevented, and the good surface acoustic wave equipment of the insertion loss in a passband is obtained. Moreover, it is better to ground, since a float electrode becomes the cause by which the unbalance between the balanced signal terminal 6 and 7 gets worse, although dummy electrode 31a floats without grounding and is good also as an electrode.

[0084]

However, with the configuration of drawing 3 , the side with which IDT1 and IDT3 are located in a line will become large by performing infanticide weighting from the side with which IDT1 and IDT40 are located in a line by the non-electric-field section 9. Now, the unbalance between enough balanced signal terminals 6 and 7 is not obtained yet. Then, as shown in drawing 4 , decussation weighting electrode finger 22a which gave decussation width-of-face weighting was set as the near signal electrode finger 22 with which IDT1 and IDT2 are located in a line, and dummy electrode 21a was prepared further. The magnitude of each nothing electric-field sections 9 and 9 in the boundary section X1 between IDT1 and IDT2 and the boundary section X2 between IDT1 and IDT3 carries out abbreviation coincidence mutually by this, and the surface acoustic wave equipment with which the unbalance between balanced signal terminals has been improved further is obtained.

[0085]

By furthermore forming dummy electrode 21a, the increment in loss by a surface acoustic wave being changed into a bulk wave is prevented, and surface acoustic wave equipment with the good insertion loss in a passband is obtained.

[0086]

Such grounded dummy electrodes 21a and 31a form the non-electric-field section 9, respectively among each ground electrode fingers 21 and 31b which adjoin each other mutually, and can control now the magnitude of the formation field (formation field of capacity) of each above-mentioned nothing electric-field section 9 to mention later.

[0087]

Although decussation weighting which was explained above is efficient since it can adjust the non-electric-field section by weighting with little direction given to a signal electrode, of course, weighting of it may be carried out to the ground electrode.

[0088]

Moreover, although the electrode finger of the part where IDT1 for an input and IDT 2 and 3 for an output adjoin each other mutually in the first gestalt of this operation, and the electrode finger to 2 Motome's electrode finger performed weighting, this may be performed in any part of IDT. According to the polar difference of the electrode finger with which IDT adjoins each other, however, the resonance mode (resonance mode of C of drawing 72 ) of a passband with large effect which is in a RF side most Since distribution of a current is large in the part where IDT adjoins each other as drawing 72 (b) shows, as shown in drawing 4 , it is effective to carry out within the limits of [ one half of ] propagation direction die-length a of the surface acoustic wave in IDT2 from each part where IDT 1 and 2 adjoins each other mutually.

[0089]

Moreover, what is necessary is just to adjust the amount of decussation width-of-face weighting if needed, although decussation width-of-face weighting is carried out with the first gestalt of operation by setting up decussation weighting electrode finger 22a which shortened the signal electrode finger 22 to the abbreviation center section. For example, about 1/of decussation width-of-face weighting of 4 is performed on the signal electrode finger 22 by the side of IDT1, and further, even if it carries out about 1/of decussation width-of-face weighting of 4 also on the following signal electrode finger 22, the same effectiveness is acquired.

[0090]

Phase unbalance is shown in the balanced signal terminal 6 to the

frequency in the configuration of the first gestalt of this operation, the amplitude unbalance between seven, and drawing 6 at drawing 5 . Moreover, as a comparison, the amplitude unbalance between the balanced signal terminals to the frequency in the configuration of the example of the first comparison shown in drawing 2 is shown in drawing 7 , and phase unbalance is shown in drawing 8 . The frequency range of the passband of the filter for EGSM transmission is 880MHz – 915MHz.

[0091]

With the first gestalt of this operation, the balanced signal terminal 6 to the frequency in this range and about 1.2dB of amplitude unbalance between seven improve to being -1.6dB – +1.5dB (amplitude unbalance being good if the deflection of 3.1dB and deflection are small) in the example of the first comparison with -0.7dB – +1.2dB (deflection of 1.9dB). The balanced signal terminal 6 and the phase unbalance between seven improve about 11 degrees with 178 – 184 degrees (six deflection) with the first gestalt of this operation to being 172 – 189 degrees (phase unbalance being good if 17 deflection and deflection are small) in the example of the first comparison.

[0092]

As explained above, with the first gestalt of this operation, the surface acoustic wave equipment with which the unbalance between the balanced signal terminal 6 and 7 has been improved rather than conventional surface acoustic wave equipment is obtained by giving weighting to the configuration of the surface acoustic wave equipment which has balanced – unbalance conversion function using one vertical joint resonator mold surface acoustic wave filter.

[0093]

Although the configuration using one vertical joint resonator mold surface acoustic wave filter which has three IDT(s) explained with the first gestalt of this operation, if this invention is surface acoustic wave equipment using the surface acoustic wave filter which has not only this configuration but the balanced signal terminals 6 and 7, the same effectiveness will be acquired in any configurations.

[0094]

For example, although drawing 9 is surface acoustic wave equipment which has balanced – unbalance conversion function using the vertical joint resonator mold surface acoustic wave filter which has five IDT(s) (balanced signal terminals 401 and 402, an unbalance signal terminal 403), the effectiveness of this invention is acquired also in the configuration using the vertical joint resonator mold surface acoustic wave filter which has three or more IDT(s) in this way, and the

configuration using the vertical joint resonator mold surface acoustic wave filter which has two IDT(s). Of course, in the surface acoustic wave equipment using a vertical joint resonator mold surface acoustic wave filter, the surface acoustic wave filter of a transversal mold, and a horizontal joint resonator mold surface acoustic wave filter, effectiveness is acquired similarly.

[0095]

Moreover, although the surface acoustic wave equipment which has balanced - unbalance conversion function explained with the first gestalt of this operation for example, drawing 10 (the pair, the balanced signal terminal 503, and the balanced signal terminal 504 serve as [ the balanced signal terminal 501 and the balanced signal terminal 502 ] a pair) and drawing 11 (the balanced signal terminal 601 and the balanced signal terminal 602 -- a pair --) the balanced signal terminal 603 and the balanced signal terminal 604 serve as a pair -- \*\*\* -- the effectiveness of this invention is acquired also in the surface acoustic wave equipment of the shown balanced signal input-balance signal output.

[0096]

Moreover, although the example which constitutes the surface acoustic wave equipment which has balanced - unbalance conversion function using one vertical joint resonator mold surface acoustic wave filter from the first gestalt of this operation explained, effectiveness is acquired in the surface acoustic wave equipment with which this invention has not only this configuration but all balanced - unbalance conversion functions.

[0097]

For example, the balanced signal terminals 701 and 702 are connected to the sinking comb-like electrode of the two poles of one IDT in one vertical joint resonator mold surface acoustic wave filter like drawing 12 , respectively (703 is an unbalance signal terminal). To the configuration and pan which do not have the electrical neutrality point grounded by the ground, like drawing 13 the configuration (for 801 and 802, a balanced signal terminal and 803 are an unbalance signal terminal) with which one of IDT(s) was divided crosswise [ decussation ] and the impedance was changed -- still like drawing 14 The effectiveness of this invention is acquired also in the configuration (903 is an unbalance signal terminal) which connects the balanced signal terminals 901 and 902 to each of the sinking comb-like electrode which it was divided in the propagation direction of a surface acoustic wave, and was divided.

[0098]

In that case, as shown in drawing 15 , the surface acoustic wave equipment with which the magnitude of attenuation outside a passband has been improved further is obtained by connecting with the sinking comb-like electrode of another direction in IDT of right and left of the unbalance signal terminal 1003, respectively (1001 and 1002 are a balanced signal terminal).

[0099]

Furthermore, also in the configuration of the surface acoustic wave equipment which has balanced - unbalance conversion function, the effectiveness of this invention is acquired combining two or more vertical joint resonator mold surface acoustic wave filters.

[0100]

For example, the phase of the output signal over the input signal of the vertical joint resonator mold surface acoustic wave filter 1105 is changed about 180 degrees to the vertical joint resonator mold surface acoustic wave filter 1104 like drawing 16 . And parallel connection of the IDT connected with series connection and the unbalance signal terminal 1103 in IDT connected with the balanced signal terminals 1101 and 1102 is carried out. Like the configuration of surface acoustic wave equipment equipped with balanced - unbalance conversion function, the configuration which carried out cascade connection of the one vertical joint resonator mold surface acoustic wave filter 1201 to the configuration of drawing 16 still like drawing 17 , and drawing 18 , even if it gives weighting to the configuration of drawing 68 , the effectiveness of this invention is acquired.

[0101]

Thus, the unbalance between balanced signal terminals is not only improved, but with the configuration which carries out cascade connection of the vertical joint resonator mold surface acoustic wave filter further, surface acoustic wave equipment with the large magnitude of attenuation outside a passband is obtained. So that the phases of the electrical signal which transmits each signal lines 1301 and 1302 which have connected the vertical joint resonator mold surface acoustic wave filter of two each which is carrying out cascade connection like drawing 19 in that case may differ about 180 degrees mutually By each thing for which IDT 1307 and 1308 is reversed mutually so that each IDT 1303 and 1304 may be reversed mutually and the phases of the electrical signal which transmits each signal lines 1305 and 1306 may differ about 180 degrees mutually similarly The surface acoustic wave equipment which has furthermore improved the unbalance between balanced signal terminals is obtained.

[0102]

As for the effectiveness of this invention, the configuration which carried out cascade connection of the one more vertical joint resonator mold surface acoustic wave filter 1401 to the surface acoustic wave equipment of drawing 12 is also obtained still like drawing 20. The unbalance between balanced signal terminals is not only improved, but with this configuration, surface acoustic wave equipment with the large magnitude of attenuation outside a passband is obtained. At this time, like drawing 21, the surface acoustic wave equipment which has improved the unbalance between balanced signal terminals further is obtained by each thing for which IDT 1503 and 1504 is reversed mutually so that the phases of the electrical signal which transmits each signal lines 1501 and 1502 like the configuration of drawing 19 may differ about 180 degrees mutually.

[0103]

Moreover, when carrying out cascade connection of the two or more vertical joint resonator mold surface acoustic wave filters, it is not necessary to use the vertical joint resonator mold surface acoustic wave filter of the especially same configuration for example, and decussation width of face is adjusted to adjust an impedance by I/O, or a design may be changed with each surface acoustic wave filter, such as changing the logarithm of IDT, the pitch of adjacent IDT(s), and the pitch of IDT and a reflector, to enlarge the magnitude of attenuation outside a passband.

[0104]

moreover -- the first gestalt of this operation -- which vertical joint resonator mold surface acoustic wave filter -- also setting -- every -- although the electrode \*\*\* number of IDT was made into odd, this may be even, it is located in the center section of three IDT(s) like especially drawing 22, and the effectiveness of this invention is acquired making into even the total number of the electrode finger of IDT further connected to a balanced signal terminal.

[0105]

In this case, symmetric property on either side improves to a vertical joint resonator mold surface acoustic wave center of filter, and since the number of the electrode finger further connected to the balanced signal terminal becomes equal, the surface acoustic wave equipment with which the unbalance between balanced signal terminals has been improved more is obtained.

[0106]

Moreover, as shown in drawing 23, the effectiveness of this invention is acquired also in the configuration which carried out series

connection of the surface acoustic wave resonators 1601 and 1602, and the configuration which carried out parallel connection of the surface acoustic wave resonator although not illustrated or the configuration which connected the both. The unbalance between balanced signal terminals is not only improved, but in this configuration, surface acoustic wave equipment especially with the large magnitude of attenuation near the passband is obtained.

[0107]

(The second gestalt of operation)

It will be as follows if the second gestalt of this operation is explained based on drawing 24 thru/or drawing 28. In addition, in the second gestalt of this operation, the member number same about the member which has the same function as the surface acoustic wave equipment shown by drawing 1 was given, and the explanation was omitted.

[0108]

With the surface acoustic wave equipment concerning the second gestalt of this operation, as the approach of weighting, as shown in drawing 24, it replaces with infanticide weighting in the first gestalt of the above-mentioned implementation, and decussation weighting in decussation width of face, and serial weighting is used. That is, it replaces with IDT2 [ given in the first gestalt of the above-mentioned implementation ], and IDT25 is formed.

[0109]

In IDT25, it replaces with the above-mentioned dummy electrode 21a of IDT2, decussation weighting electrode finger (electrode finger for second balance) 21b which shortened the ground electrode finger (degree) 21 inside decussation weighting electrode finger 22a like decussation weighting electrode finger 22a is prepared, and dummy electrode 25a estranged with above-mentioned both (that is, condition which floated) is prepared further.

[0110]

The above-mentioned dummy electrode 25a by decussation weighting electrode finger 22a and this width of face between decussation weighting electrode finger 22a and the following signal electrode fingers 22 It extends almost in parallel with them. Between the point of decussation weighting electrode finger 22a, and the points of decussation weighting electrode finger 21b A passage, Furthermore, it is the electrode finger formed by bending in between decussation weighting electrode finger 21b and the ground electrode fingers 21 besides \*\* so that it may extend almost in parallel with them.

[0111]

About the surface acoustic wave equipment which has such IDT25, the amplitude unbalance and phase unbalance near the passband were measured, respectively. Those results were shown in drawing 25 and drawing 26 , respectively. Although the amplitude unbalance between the frequency-balance signal terminals in the range of the passband of the filter for EGSM transmission is the same as -0.7dB - +1.2dB (deflection of 1.9dB), and the first gestalt of operation so that clearly from those results, the phase unbalance between balanced signal terminals improves once [ further ] rather than 177 - 182 degrees (five deflection) and the first gestalt of operation.

[0112]

Furthermore, the transmission characteristic in the passband to the frequency in the first gestalt of operation was shown in drawing 27 , and the transmission characteristic in the passband to the frequency in the second gestalt of operation was shown in drawing 28 . Although Ripple A (refer to drawing 27 ) will have occurred in a passband with the first gestalt of operation if above-mentioned both are compared, in the second gestalt of operation, the above-mentioned ripple A does not occur (refer to drawing 28 ), but surface acoustic wave equipment with the deflection smaller than the first gestalt of operation in a passband is obtained.

[0113]

As explained above, the surface acoustic wave equipment with which the unbalance between balanced signal terminals and the deflection in a passband have been improved further is obtained by carrying out serial weighting which extended decussation width-of-face weighting further.

[0114]

Moreover, with the second gestalt of this operation, even if compared with the first gestalt of said operation, generating of a ripple is controlled in the transmission characteristic and it turns out that it has the more excellent transmission characteristic.

[0115]

(The third gestalt of operation)

It will be as follows if the third gestalt of operation of this invention is explained based on drawing 29 thru/or drawing 32 . The configuration which relates to the first gestalt of operation of this invention at drawing 29 is shown. In addition, the third gestalt of this operation explains taking the case of the filter for PCS reception.

[0116]

a book -- operation -- the -- three -- a gestalt -- a surface acoustic wave -- equipment -- \*\*\* -- piezo-electricity -- a substrate -- 200 --

a top -- three -- IDT -- length -- association -- a resonator -- a mold -- a surface acoustic wave -- a filter -- 201 -- a surface acoustic wave -- a filter -- 201 -- series connection -- carrying out -- having had -- each -- a surface acoustic wave -- a resonator -- 202 -- 203 -- photolithography -- a method -- etc. -- forming -- having had -- aluminum -- ( -- aluminum -- ) -- an electrode (foil) -- forming -- having -- \*\*\* . As a material of the above-mentioned piezo-electric substrate 200, it is the 40 \*\*5-degreeYcutX propagation LiTa03. It is mentioned. Such a surface acoustic wave filter 201 is almost the same as that of what was shown in above-mentioned drawing 10 .

[0117]

In the surface acoustic wave filter 201, each IDT 204 and 206 is formed, respectively that it seems that IDT205 which takes the lead and becomes a balanced signal terminal side is put from right and left (meeting in the propagation direction of a surface acoustic wave). Furthermore, each reflectors 207 and 208 which reflect the surface acoustic wave from each above 204-IDT 206 in each outsides (meeting in the propagation direction of a surface acoustic wave) of both of IDT 204 and 206 are formed, respectively. That is, each IDT and reflector are set up on the propagation path of the above-mentioned surface acoustic wave so that the cross direction of each electrode finger may meet in the propagation direction of a surface acoustic wave.

[0118]

furthermore, the pitch of several electrode fingers (\*\* pitch electrode finger) of the parts where IDT205 and IDT206 adjoin mutually the parts where IDT204 and IDT205 adjoin each other mutually and those near, and a list with the surface acoustic wave filter 201 so that clearly from drawing 29 , and those near -- the above-mentioned -- the same -- above-mentioned every -- it has set up so that it may become smaller than other parts of IDT (part of 213 and 214 of drawing 29 ).

[0119]

In the above-mentioned surface acoustic wave equipment, each terminals 210 and 211 are balanced signal terminals, and a terminal 209 is an unbalance signal terminal. Therefore, IDT204 and IDT206 became the unbalance signal side, and are equipped with signal electrode finger 204a and ground electrode finger 204b, signal electrode finger 206a, and ground electrode finger 206b, respectively. On the other hand, IDT205 became the balanced signal terminal side, and will be equipped with each signal electrode fingers 205a and 205b. Therefore, the third gestalt of this operation is the example which gave weighting to the configuration which does not have the electrical neutrality point grounded by the

ground.

[0120]

Series connection of each surface acoustic wave resonators 202 and 203 is carried out to the unbalance signal terminal 209 between [ of IDT 204 and 206 ] each through the signal line 212. The surface acoustic wave resonator 202 has each reflectors 202b and 202c along the propagation direction of a surface acoustic wave so that IDT202a and it may be inserted. The surface acoustic wave resonator 203 has each reflectors 203b and 203c along the propagation direction of a surface acoustic wave so that IDT203a and it may be inserted.

[0121]

The description of the third gestalt of this operation is a point in the part which IDT205 and IDT206 adjoined mutually and have met in the propagation direction of a surface acoustic wave by which weighting is thinned out and carried out in the part of the electrode finger 219 of IDT206.

[0122]

With the third gestalt of this operation, as the above-mentioned infanticide weighting, the electrode finger of the part (the nearer one) which adjoins IDT205 in signal electrode finger 206a of IDT206 thins out, and weighting is carried out.

[0123]

and every which secures the pitch of each electrode finger and adjoins each other mutually with the third gestalt of this operation -- IDT, i. e., every, -- in order to maintain spacing between IDT(s) 205 and 206, the electrode finger 219 is formed in ground electrode finger 206b with the same decussation width of face as ground electrode finger 206b by the side of a \*\* pitch, this pitch, this duty, and the same line breadth. By this, in IDT206, two or more, each other will be adjoined mutually and two ground electrode finger 206b will exist in the part which adjoins IDT205.

[0124]

the wavelength decided by the pitch of lambdaI2 (213 of drawing 29 , 214 parts), and other electrode fingers in the wavelength it is decided in the pitch of a \*\* pitch electrode finger that the detailed design of the surface acoustic wave filter 201 will be -- lambdaI1 \*\* -- if it carries out

Decussation Width-of-face W: 60.6lambdaI1

IDT number (order of 204, 205, and 206): -- (4)2929(4) / (4)44(4)

(number of the electrode finger with which the inside of a parenthesis made the pitch small)

lambdaI1:2.06 micrometer IDT wavelength, lambdaI2:1.88 micrometer Reflector wavelength lambdaR:2.07micrometer Reflector number: 100 IDT-IDT spacing: 0.50lambdaI2 Spacing (215, 216, 217, 218 of drawing 29 ):0.25lambdaI1+0.25lambdaI2 of the part across which it faced with each electrode finger of wavelength lambdaI1 and wavelength lambdaI2

IDT-reflector spacing: 0.47lambdaR duty: 0.60 (IDT and reflector)

Electrode-layer thickness: 0.080lambdaI1

The detailed design of the surface acoustic wave resonator 202 is shown below.

Decussation Width-of-face W: 40.61lambda

IDT number: 241

Wavelength of lambda (IDT and reflector):1.97 micrometers

Reflector number: 30

IDT-reflector spacing: 0.50lambda

duty: 0.60 (IDT and reflector)

Electrode-layer thickness: 0.084lambda

The detailed design of the surface acoustic wave resonator 203 is shown below.

Decussation Width-of-face W: 49.11lambda

IDT number: 401

Wavelength of lambda (IDT and reflector):2.04 micrometers

Reflector number: 30

IDT-reflector spacing: 0.50lambda

duty: 0.60 (IDT and reflector)

Electrode-layer thickness: 0.080lambda

The above-mentioned "spacing" is the distance between cores (core in the cross direction) of two electrode fingers which adjoin each other mutually.

[0125]

Next, each property of the third gestalt of this operation is measured, and those results are shown in drawing 30 and drawing 31 . The graph which shows the measurement result of the amplitude unbalance between the balanced signal terminals to a frequency in the configuration of the third gestalt of this operation is shown in drawing 30 , and the graph of phase unbalance is shown in drawing 31 .

[0126]

As a comparison, it thins out in the part which is shown in drawing 32 and where two IDT(s) adjoin each other, and the amplitude unbalance in

the configuration of the example of the second comparison which replaces with IDT206 IDT206c to which weighting is not given, and it has, and phase unbalance are also shown according to drawing 30 and drawing 31 . [0127]

The configuration of the example of the second comparison of drawing 32 is the completely same configuration except replacing with IDT206 IDT206c which has not given infanticide weighting, and having it to the third gestalt of operation. The frequency range of the passband in the filter for PCS reception is 1930MHz – 1990MHz.

[0128]

With the third gestalt of operation, -1.5dB – +0.7dB (deflection of 2.2dB) and about 0.1dB amplitude unbalance have improved the maximum amplitude unbalance in this range to being -1.6dB – +0.7dB (deflection of 2.3dB) in the example of the second comparison. Next, with the third gestalt of operation, whenever [ phase equilibrium ] has improved phase unbalance about once [ about ] with 162 – 181 degrees (19 deflection) to being 162 – 182 degrees (20 deflection) in the example of the second comparison.

[0129]

This is giving infanticide weighting and the polarity of the electrode finger in the part where IDT205 and IDT206 adjoin each other mutually is the effectiveness that it became same – and same + as the polarity of the part where IDT204 and IDT205 adjoin each other mutually with the third gestalt of this operation that both were signal electrode fingers in + and +, and asymmetry on either side has been improved, in the example of the second comparison.

[0130]

As explained above, with the third gestalt of this operation, the surface acoustic wave filter with which the unbalance between balanced signal terminals has been improved rather than the conventional surface acoustic wave filter is obtained in the surface acoustic wave filter which has balanced – unbalance conversion function by thinning out and carrying out weighting of the electrode finger of the part where two IDT(s) adjoin each other mutually.

[0131]

(The fourth gestalt of operation)

The fourth gestalt of operation of this invention is explained based on drawing 33 thru/or drawing 41 . The fourth gestalt of operation explains taking the case of the filter for EGSM reception.

[0132]

Balanced signal terminal 1906 and 1907 side each vertical joint

resonator mold surface acoustic wave filters 1918 and 1920 with which the phase of the output signal over an input signal which showed the surface acoustic wave equipment concerning the fourth gestalt of operation to drawing 18 is different from each other about 180 degrees and whose number is two Series connection, Carry out parallel connection of the unbalance signal terminal 1905 side, and it gives balanced - unbalance conversion function. It considers as the configuration which was alike, respectively and carried out cascade connection of every one new vertical joint resonator mold surface acoustic wave filters 1918 and 1918. furthermore, two vertical joint resonator mold surface acoustic wave filters 1918 and 1920 -- It is the example which gives infanticide weighting to the above-mentioned vertical joint resonator mold surface acoustic wave filter 1920, and has dummy electrode 1901b in it.

[0133]

With the fourth gestalt of operation, four vertical joint resonator mold surface acoustic wave filters 1918 and 1920 are formed with aluminum electrode on the piezo-electric substrate 8. Four vertical joint resonator mold surface acoustic wave filters 1918 and 1920 are the same designs except [ all ] the point that the phases of the output signal over an input signal differ about 180 degrees, and the point by which weighting is carried out. Moreover, with the fourth gestalt of operation, like the third gestalt of operation, while two IDT(s) adjoin each other, the several \*\* pitch electrode finger is formed. The configuration of the fourth gestalt of operation is fundamentally the same as the configuration of the second conventional example shown in drawing 68 except the point of weighting.

[0134]

If the detailed design of the vertical joint resonator mold surface acoustic wave filter 1918 sets to  $\lambda_{d1}$  wavelength decided by the pitch of  $\lambda_{d2}$  and other electrode fingers in the wavelength decided by the pitch of a \*\* pitch electrode finger,

Decussation width of face:  $25.2\lambda_{d1}$

IDT number (order of 1902, 1901, and 1903): 26 (4)/23(4) / (4) 23 (4)  
book (number of the electrode finger with which the inside of a parenthesis narrowed the pitch)

IDT wavelength  $\lambda_{d1}$  : 4.204 micrometers,  $\lambda_{d2}$  : 3.854 micrometers

Reflector wavelength  $\lambda_{R}$ : 4.279 micrometer

Reflector number: 90

IDT-IDT spacing :

Wavelength  $\lambda_{d1}$  Wavelength  $\lambda_{d2}$  Part:  $0.25\lambda_{d1} + 0.25\lambda_{d2}$

inserted into the electrode finger

Wavelength  $\lambda/2$  Part:  $0.50\lambda/2$  inserted into the electrode finger

IDT-reflector spacing:  $0.470\lambda/2$

IDTduty: 0.720

Reflector duty: 0.55

electrode layer thickness: --  $0.08\lambda/2$  it is .

[0135]

the description of the fourth gestalt of operation be the point of prepare the dummy electrode 1901 b locate in the both ends of the IDT 1901 a reverse a in order it change the phase of the output signal over the input signal of the vertical joint resonator mold surface acoustic wave filter 1920 about 180 degrees to the vertical joint resonator mold surface acoustic wave filter 1918 , and one of the two of an electrode finger connect with the unbalance signal terminal 1905 be thin out , and connect b to the part at a ground .

[0136]

Next, an operation and effectiveness of the fourth gestalt of this operation are explained. The amplitude unbalance between the balanced signal terminals to the frequency in the configuration of the fourth gestalt of operation is shown in drawing 34 . As a comparison, the amplitude unbalance between the balanced signal terminals to the frequency in the second conventional example of drawing 68 is also shown in drawing 34 . The configuration of the second conventional example of drawing 68 is the completely same configuration except having not given infanticide weighting to the fourth gestalt of operation. The frequency range of the passband in the filter for EGSM reception is 925MHz - 960MHz.

[0137]

With the fourth gestalt of operation,  $-0.7\text{dB} - +0.2\text{dB}$  (deflection of  $0.9\text{dB}$ ) and about  $0.6\text{dB}$  amplitude unbalance have improved the amplitude unbalance between the balanced signal terminals in this range to being  $-0.2\text{dB} - +1.3\text{dB}$  (deflection of  $1.5\text{dB}$ ) in the second conventional example.

[0138]

Below, why the effectiveness of the fourth gestalt of operation was acquired is explained. Excitation of a surface acoustic wave is performed by the electrode \*\*\*\*, when the electrode finger with which polarities differ adjoins. It illustrates about the excitation condition of the surface acoustic wave in the circumference (part enclosed by 0 by drawing 68 ) in which IDT(s) in each surface acoustic wave filters 118 and 127 given in drawing 68 adjoin drawing 35 .

[0139]

In drawing 35, only three electrode fingers are shown from the edge of a part where IDT adjoins, respectively, and it is omitting about others. The vertical joint resonator mold surface acoustic wave filters 118 and 127 of drawing 68 are set in the vertical joint resonator mold surface acoustic wave filters 2007 and 2008, IDT 113, 114, and 115 of drawing 68 is set to drawing 35 in drawing 35, and IDT 133, 134, and 135 of drawing 6868 supports IDT 2001, 2002, and 2003 at IDT 2004, 2005, and 2006 of drawing 35, respectively. The part which attaches 0 all over drawing shows that a surface acoustic wave is excited and a surface acoustic wave is not excited in the part which attaches x.

[0140]

the case of the second conventional example -- the vertical joint resonator mold surface acoustic wave filter 2007 -- setting -- IDT 2001, 2002, and 2003 -- since each outermost electrode finger is a ground electrode, excitation of a surface acoustic wave is not performed between each adjoining electrode finger.

[0141]

On the other hand, since the phase of the output signal over an input signal with the vertical joint resonator mold surface acoustic wave filter 2007 is changed about 180 degrees in the vertical joint resonator mold surface acoustic wave filter 2008 by IDT2001 of the vertical joint resonator mold surface acoustic wave filter 2007, and IDT2004 which reversed the sense, the outermost electrode finger of IDT2004 is a signal electrode, and the outermost electrode finger of IDT 2005 and 2006 is a ground electrode.

[0142]

Therefore, in the vertical joint resonator mold surface acoustic wave filter 2008, if unlike the case of the vertical joint resonator mold surface acoustic wave filter 2007 excitation of a surface acoustic wave is performed between each adjoining electrode finger and it compares on the whole, compared with the vertical joint resonator mold surface acoustic wave filter 2007, two parts where excitation of a surface acoustic wave is performed will increase with the vertical joint resonator mold surface acoustic wave filter 2008.

[0143]

Spacing of the resonance mode located in the center among three resonance modes which the intensity distributions of the active current of the surface acoustic wave in the electrode finger spacing section which is with the vertical joint resonator mold surface acoustic wave filter 2007 and the vertical joint resonator mold surface acoustic wave filter 2008, and adjoins in the second conventional example by this

differ, consequently are shown in drawing 72 , and the resonance mode most located in a high region side differed, and the unbalance between balanced signal terminals was getting worse.

[0144]

Next, it illustrates about the excitation condition of the surface acoustic wave in the circumference (part enclosed by 0 all over drawing) in which IDT(s) in the vertical joint resonator mold surface acoustic wave filters 1918 and 1920 shown in drawing 33 adjoin drawing 36 . Also in drawing 36 , like drawing 35 , only three electrode fingers are shown from the edge of a part where IDT adjoins, respectively, and it is omitting about others.

[0145]

IDT 1901a, 1902, and 1903 of the vertical joint resonator mold surface acoustic wave filter 1920 in drawing 33 supports [ the vertical joint resonator mold surface acoustic wave filters 1918 and 1920 in drawing 33 / IDT 1902, 1901 and 1903 of the vertical joint resonator mold surface acoustic wave filter 1918 in drawing 33 ] the vertical joint resonator mold surface acoustic wave filters 2107 and 2108 of drawing 36 at IDT 2104, 2105, and 2106 of drawing 36 again at IDT 2102, 2101, and 2103 of drawing 36 , respectively.

[0146]

In the vertical joint resonator mold surface acoustic wave filter 2108 which changed the phase of the output signal over the vertical joint resonator mold surface acoustic wave filter 2107 and an input signal about 180 degrees, weighting of the outermost electrode finger of IDT2104 was thinned out and carried out by reversing the sense of IDT connected to the input side in the case of the fourth gestalt of operation, the dummy electrode 2109 (dummy electrode 1901b of drawing 33 ) was formed in the part, and it has connected with a ground.

[0147]

For this reason, with the vertical joint resonator mold surface acoustic wave filter 2108, in the part 2110 which one two IDT(s) adjoin, to a surface acoustic wave being excited since a signal electrode finger and a ground electrode finger are located in a line by turns, since three ground electrode fingers are located in a line in the part 2111 which another two IDT(s) adjoin, two parts by which a surface acoustic wave is not excited occur.

[0148]

Consequently, in the vertical joint resonator mold surface acoustic wave filter 2107 and the vertical joint resonator mold surface acoustic wave filter 2108, since the total of the part where a surface acoustic wave

is not excited between electrode fingers, i.e., the total of the part where a surface acoustic wave is excited between electrode fingers, becomes equal, as compared with the second conventional example, the difference of spacing of resonance mode becomes small, and the amplitude unbalance between balanced signal terminals is improved.

[0149]

For example, the 1st vertical joint resonator mold surface acoustic wave filter 2202 which connected the vertical joint resonator mold surface acoustic wave filter 2201 as shown in drawing 37 to two-step concatenation, By reversing the sense of IDT2203 of vertical joint resonator mold surface acoustic wave filter 2201a connected to the 2nd step of output side to the 1st vertical joint resonator mold surface acoustic wave filter 2202 It has the 2nd vertical joint resonator mold surface acoustic wave filter 2204 which changed the phase of an output signal [ as opposed to an input signal in the 1st vertical joint resonator mold surface acoustic wave filter 2202 ] about 180 degrees. IDT of the center in the 1st step of each vertical joint resonator mold surface acoustic wave filter 2201 is connected to juxtaposition. The unbalance signal terminal 2205 IDT of the center of the 2nd step of each vertical joint resonator mold surface acoustic wave filters 2201 and 2201a might be connected to the serial, and the balanced signal terminal 2206 may have been constituted.

[0150]

By thinning out and carrying out weighting of the outermost electrode finger of IDT2203 also by the above-mentioned case, forming the dummy electrode 2207 in the part, and connecting with a ground The excitation condition of the surface acoustic wave in the circumference (part enclosed with 0 in drawing 37 ) in which two IDT(s) in the vertical joint resonator mold surface acoustic wave filter of an output side adjoin becomes like drawing 38 . In the 1st vertical joint resonator mold surface acoustic wave filter 2202 and the 2nd vertical joint resonator mold surface acoustic wave filter 2204 Since the total of the part where a surface acoustic wave is not excited between electrode fingers, i.e., the total of the part where a surface acoustic wave is excited between electrode fingers, becomes equal mutually, the amplitude unbalance between balanced signal terminals is improved.

[0151]

Moreover, as shown in drawing 39 , the phase of the output signal over an input signal may be changed about 180 degrees by reversing not the center IDT of the 2nd step of vertical joint resonator mold surface acoustic wave filter but the sense of outside IDT.

[0152]

By thinning out and carrying out weighting of the outermost electrode finger of IDT of one of the two of IDT2301 which reversed the sense in the above-mentioned case, forming the dummy electrode finger 2302 in the part, and connecting with a ground The excitation condition of the surface acoustic wave in the circumference (part enclosed with 0 of drawing 3939 ) in which two IDT(s) in the vertical joint resonator mold surface acoustic wave filter of an output side adjoin As shown in drawing 40 , it sets in the 1st vertical joint resonator mold surface acoustic wave filter 2303 and the 2nd vertical joint resonator mold surface acoustic wave filter 2304. Since the total of the part where a surface acoustic wave is not excited between electrode fingers, i. e., the total of the part where a surface acoustic wave is excited between electrode fingers, becomes equal mutually, the amplitude unbalance between balanced signal terminals is improved.

[0153]

Moreover, as shown in drawing 41 , when a 5IDT type vertical joint resonator mold surface acoustic wave filter is used and constituted instead of the 3IDT type vertical joint resonator mold surface acoustic wave filter in drawing 33 , it also sets. By thinning out and carrying out weighting of the outermost electrode finger of one side of IDT of IDT2401 which reversed the sense, forming the dummy electrode finger 2402 in the part, and connecting with a ground In the 1st vertical joint resonator mold surface acoustic wave filter 2403 and the 2nd vertical joint resonator mold surface acoustic wave filter 2404 Since the total of the part where a surface acoustic wave is not excited between electrode fingers, i. e., the total of the part where a surface acoustic wave is excited between electrode fingers, becomes equal mutually, the amplitude unbalance between balanced signal terminals is improved.

[0154]

With the fourth gestalt of operation, a balanced signal terminal side the surface acoustic wave filter which is two from which the phase of the output signal over an input signal differs about 180 degrees as explained As mentioned above, series connection, An unbalance signal terminal side is carrying out parallel connection, giving balanced - unbalance conversion function, thinning out in the configuration which carried out cascade connection of every one surface acoustic wave filter to each of two more surface acoustic wave filters, and giving weighting. The surface acoustic wave equipment with which the unbalance between balanced signal terminals has been improved rather than conventional surface acoustic wave equipment is obtained.

[0155]

(The fifth gestalt of operation)

The fifth gestalt of operation of this invention is explained based on drawing 42 thru/or drawing 46 . The fifth gestalt of this operation explains taking the case of the filter for DCS reception.

[0156]

It is the example which gave weighting to the configuration which the series connection and unbalance signal terminal side carried out parallel connection of the vertical joint resonator mold surface acoustic wave filter with which the phases of the output signal over an input signal which showed the fifth gestalt of operation to drawing 16 differ about 180 degrees, and whose number is two as for the balanced signal terminal side, and gave balanced - unbalance conversion function.

[0157]

With the fifth gestalt of operation, the surface acoustic wave resonators 2502 and 2503 by which series connection was carried out to the vertical joint resonator mold surface acoustic wave filter 2501 and the vertical joint resonator mold surface acoustic wave filter 2501 are formed with aluminum electrode on the above-mentioned piezo-electric substrate 8. Two vertical joint resonator mold surface acoustic wave filters are the same designs except that [ all ] the phases of the output signal over an input signal differ about 180 degrees. Moreover, with the fifth gestalt of operation, like the third gestalt of operation, while two IDT(s) adjoin each other, several \*\* pitch electrode fingers are formed.

[0158]

If the detailed design of a vertical joint resonator mold surface acoustic wave filter sets to  $\lambda_{d11}$  wavelength decided by the pitch of  $\lambda_{d12}$  and other electrode fingers in the wavelength decided by the pitch of a \*\* pitch electrode finger,

Decussation width of face:  $37.12\lambda_{d11}$

IDT number (order of 2504, 2505, and 2506): (4) 19-/31 (4)/(4) 19 (4) book (number of the electrode finger with which the inside of a parenthesis narrowed the pitch)

$\lambda_{d11}$ :2.156 micrometer IDT wavelength,  $\lambda_{d12}$ :1.926 micrometer

Reflector wavelength  $\lambda_{dR}$ :2.177micrometer

Reflector number: 150

IDT-IDT spacing: Part:0.25 $\lambda_{d11}$ +0.25 $\lambda_{d12}$  inserted into wavelength  $\lambda_{d11}$  and the electrode finger of  $\lambda_{d12}$ , part:0.50 $\lambda_{d12}$  which were inserted into the electrode finger of wavelength  $\lambda_{d12}$

IDT-reflector spacing: 0.50 $\lambda_{dR}$

IDTduty:0.63

Reflector duty: 0.60

Electrode-layer thickness: 0.09lambdaI

The detailed design of the surface acoustic wave resonator 2502 is shown below.

Decussation width of face: 14.3lambdaI

IDT number: 241

IDT wavelength and reflector wavelength: 2.102 micrometers

Reflector number: 30

IDT-reflector spacing: 0.50lambdaR

The detailed design of the surface acoustic wave resonator 2503 is shown below.

Decussation width of face: 37.1lambdaI

IDT number: 241

IDT wavelength and reflector wavelength: 2.023 micrometers

Reflector number: 30

IDT-reflector spacing: It is 0.50lambdaR.

[0159]

the description of the fifth gestalt of operation be the point which one of the two of a signal electrode finger which made it reversed in order to change the phase of the output signal over the input signal of the surface acoustic wave filter 2508 about 180 degrees to the surface acoustic wave filter 2507 , and which be locate in the edge of IDT 2509 be thinned out , have form the dummy electrode 2510 connected to the part at the ground , and have communalize each three ground electrodes of IDT through the dummy electrode 2510 further .

[0160]

Next, an operation and effectiveness of the fifth gestalt of this operation are explained. First, the amplitude unbalance between the balanced signal terminals to the frequency in the configuration of the fifth gestalt of the operation to drawing 43 is shown. The amplitude unbalance between the balanced signal terminals to the frequency in the example of the third comparison shown in drawing 44 as a comparison is also shown according to drawing 43 . The configuration of the example of the third comparison of drawing 44 is the completely same configuration except having not given infanticide weighting to the fifth gestalt of operation.

[0161]

The frequency range of the passband in the filter for DCS reception is 1805MHz - 1880MHz. With the fifth gestalt of operation, -0.5dB - +1.5dB (deflection of 2.0dB) and about 2.2dB amplitude unbalance have improved

the amplitude unbalance between the balanced signal terminals in this range to being -1.0dB - +3.2dB (deflection of 4.2dB) in the example of the third comparison.

[0162]

When why the effectiveness of the fifth gestalt of operation was acquired is explained, as the example of the third comparison shown in drawing 44 shows to drawing 45 As opposed to the number of the parts where the surface acoustic wave in the circumference (part enclosed with 0 of drawing 44 ) in which IDT(s) adjoin is excited differing with the 1st surface acoustic wave filter 2601 and the 2nd surface acoustic wave filter 2602 The number of the parts where the surface acoustic wave in the circumference (part enclosed with 0 of drawing 42 ) in which in the case of the fifth gestalt of operation IDT(s) adjoin as shown in drawing 46 is excited becomes the same with the 1st vertical joint resonator mold surface acoustic wave filter 2511 and the 2nd surface acoustic wave filter 2512. For this reason, spacing of the resonance mode seen in the center of a band of the three resonance modes shown in drawing 72 and the resonance mode seen at a band quantity region side is because it was in agreement from the example of the third comparison between the signals outputted from two balanced signal terminals.

[0163]

It is thinning out in the configuration which the series-connection and unbalance signal terminal side's carried out parallel connection of the vertical joint resonator mold surface acoustic wave filter with which the phases of the output signal over an input signal differ about 180 degrees with the fifth gestalt of operation, and whose number's is two as for a balanced signal terminal side, and gave balanced - unbalance conversion function, and giving weighting as mentioned above, and the surface acoustic wave equipment with which the unbalance between balanced signal terminals has be improve rather than conventional surface acoustic wave equipment is obtain.

[0164]

The ground of surface acoustic wave equipment is strengthened with communalizing each three grounds of IDT also including the dummy electrode 2510 prepared in the location furthermore thinned out, and the insertion loss in a passband and the magnitude of attenuation outside a passband are improved by it. Furthermore, it also becomes possible to omit the grounding terminal of IDT of a center section.

[0165]

(The sixth gestalt of operation)

The sixth gestalt of operation concerning this invention is explained

based on drawing 47 thru/or drawing 54 . The sixth gestalt of this operation explains taking the case of the filter for DCS reception.  
[0166]

The sixth gestalt of operation is the example which the balanced signal terminals 2711 and 2712 were connected to the sinking comb-like electrode used as the two poles of one IDT2704 in one vertical joint resonator mold surface acoustic wave filter 2701 as well as the third gestalt of operation, respectively, and gave weighting to the configuration which does not have the electrical neutrality point grounded by the ground in each balanced signal terminals 2711 and 2712.

[0167]

With the sixth gestalt of operation, the surface acoustic wave resonators 2702 and 2703 by which series connection was carried out to the vertical joint resonator mold surface acoustic wave filter 2701 and the vertical joint resonator mold surface acoustic wave filter 2701 are formed with aluminum electrode on the piezo-electric substrate 8 mentioned above.

[0168]

The configuration of the vertical joint resonator mold surface acoustic wave filter 2701 arranges IDT 2705 and 2706 to right and left of IDT2704, and reflectors 2707 and 2708 are formed so that these IDT(s) may be put.

[0169]

With the sixth gestalt of operation, like the third gestalt of operation, while two IDT(s) adjoin each other, several \*\* pitch electrode fingers are formed (part of 2709 and 2710 of drawing 47 ). Terminals 2711 and 2712 are balanced signal terminals, and 2713 is an unbalance signal terminal. Drawing which expanded between IDT(s) 2704 and 2705 of drawing 47 to drawing 48 is shown.

[0170]

Dummy electrode 2705a is prepared in the part where decussation width-of-face weighting of the outermost electrode finger 2704a of IDT2704 connected to the balanced signal terminal 2711 was carried out, and weighting was further carried out, and it was deleted, and it connects with the ground.

[0171]

If the detailed design of the vertical joint resonator mold surface acoustic wave filter 2701 sets to  $\lambda_{d11}$  wavelength decided by the pitch of  $\lambda_{d12}$  and other electrode fingers in the wavelength decided by the pitch of a \*\* pitch electrode finger,

Decussation width of face: Partial (2805 of drawing 48 ):71.2 $\lambda_{d11}$  which does not carry out decussation width-of-face weighting

Partial (2806 of drawing 48 ) :35.6lambdaI1 which carried out decussation width-of-face weighting

IDT number (order of 2705, 2704, and 2706) : -- (4)2121(4) / (4)35(4)  
(number of the electrode finger with which the inside of a parenthesis made the pitch small)

lambdaI1:2.18 micrometer IDT wavelength, lambdaI2:1.96 micrometer

Reflector wavelength lambdaR:2.18micrometer

Reflector number: 150

IDT-IDT spacing: Part (2714 of drawing 47 ) :0.25lambdaI1+0.25lambdaI2 inserted into wavelength lambdaI1 and the electrode finger of lambdaI2  
Part (2715 of drawing 47 ) :0.50lambdaI2 inserted into the electrode finger of wavelength lambdaI2

IDT-reflector spacing: 0.460lambdaR

IDTduty: Partial:0.63 which have not narrowed the pitch, partial:0.60 which narrowed the pitch

Reflector duty: 0.57

Electrode-layer thickness: 0.09lambdaI1

The detailed design of the surface acoustic wave resonator 2702 is shown below.

Decussation width of face: 23.6lambdaI

IDT number: 241

IDT wavelength and reflector wavelength: 2.12 micrometers

Reflector number: 30

IDT-reflector spacing: 0.50lambdaR

The detailed design of the surface acoustic wave resonator 2703 is shown below.

Decussation width of face: 58.5lambdaI

IDT number: 241

IDT wavelength and reflector wavelength: 2.04 micrometers

Reflector number: 30

IDT-reflector spacing: It is 0.50lambdaR.

[0172]

The description of the sixth gestalt of operation is a point which a ground electrode finger is adjoined, decussation weighting electrode finger 2704a which carried out decussation width-of-face weighting of the electrode finger located in the both ends of IDT2704 of the center connected to the balanced signal terminal, respectively is formed, and the dummy electrodes 2705a and 2706a are formed in the part by which decussation width-of-face weighting was carried out further, respectively, and is connected to the ground.

[0173]

Next, an operation and effectiveness of the sixth gestalt of this operation are explained. The amplitude unbalance between the balanced signal terminals to the frequency in the configuration of the sixth gestalt of operation is shown in drawing 49. The amplitude unbalance between the balanced signal terminals to the frequency in the example of the fourth comparison shown in drawing 50 as a comparison is also shown according to drawing 49. The configuration of the example of the fourth comparison of drawing 50 R>0 is the completely same configuration except having used vertical joint resonator mold surface acoustic wave filter 2701a to which decapsulation width-of-face weighting of the electrode finger of the both ends of Center IDT is not carried out to the sixth gestalt of operation. The frequency range of the passband in the filter for DCS reception is 1805MHz - 1880MHz.

[0174]

With the sixth gestalt of operation, -2.0dB - +1.9dB (deflection of 3.9dB) and about 0.7dB amplitude unbalance have improved the amplitude unbalance between the balanced signal terminals in this range to being -1.3dB - +3.3dB (deflection of 4.6dB) in the example of the fourth comparison.

[0175]

Although the amplitude unbalance between balanced signal terminals has furthermore separated greatly in + side in the example of the fourth comparison, the gap of the direction of + and the direction of - is almost equal with the sixth gestalt of operation. There is a merit that the noise level of an inphase signal becomes small rather than the one where a gap of the direction of + and the direction of - is almost more equal has separated greatly in one of + side and the - sides like the sixth gestalt of operation, and the direction of the sixth gestalt of operation is excellent also in this point.

[0176]

By preparing a dummy electrode in the part by which the reason the effectiveness of the sixth gestalt of operation was acquired carried out decapsulation width-of-face weighting of the electrode finger of the both ends of the center IDT2704 which adjoins a ground electrode finger, and decapsulation width-of-face weighting was carried out further, and connecting with a ground in order for the electrode finger of the both ends of IDT connected to the balanced signal terminal 2711 and IDT connected to the balanced terminal 2712 to adjoin a ground electrode finger, it is because the polar relation with the electrode finger which is alike, respectively and adjoins became the same.

[0177]

Next, the result of having investigated the optimum value of decussation width-of-face weighting is explained. The approach of investigation was the configuration of drawing 47 and drawing 48, and the decussation width of face 2806 of the part to the decussation width of face 2805 of the part which does not carry out decussation width-of-face weighting which carries out weighting changed it comparatively (henceforth, ratio of decussation width-of-face weighting), and it investigated change of the amplitude unbalance between balanced signal terminals in the passband accompanying it.

[0178]

The ratio of decussation width-of-face weighting set the case of 1 and drawing 47 to one half for the case of drawing 50 which does not carry out weighting, and investigated the amplitude unbalance between balanced signal terminals about the case where the ratios of decussation width-of-face weighting are 1/4, 1/2, and 3/4. A value is shown as a result of the amplitude unbalance between the balanced signal terminals when changing the ratio of decussation width-of-face weighting to drawing 51. In drawing 51, the amplitude unbalance between balanced signal terminals is plotting a part for the gap by the side of +.

[0179]

When the ratio of decussation width-of-face weighting is considered as abbreviation 0.5 (i.e., when weighting is carried out in the location of the center of abbreviation of an electrode finger), the amplitude unbalance between the balanced signal terminals in a passband serves as min from drawing 51. By this having carried out weighting of the electrode finger of the both ends of Center IDT in the location of the center of abbreviation, and having connected to the ground the electrode finger by which weighting was carried out it is the effectiveness to which the polar relation with the electrode finger which resembles it, respectively and adjoins it since a ground electrode finger adjoins the electrode finger of the both ends of IDT connected to the balanced signal terminal 2711 and IDT connected to the balanced signal terminal 2712 in the abbreviation one half of the whole decussation width of face, respectively became the same.

[0180]

As mentioned above, one IDT [ in / as explained / at the sixth gestalt of operation / one vertical joint resonator mold surface acoustic wave filter ] (preferably central IDT), In the configuration which does not have the electrical neutrality point which the balanced signal terminal was connected to the sinking comb-like electrode of two poles, respectively, and was grounded by the ground Decussation width-of-face

weighting of the electrode finger of the both ends of Center IDT is carried out in the location of the center of abbreviation, and the surface acoustic wave equipment which has improved the amplitude unbalance between balanced signal terminals rather than conventional surface acoustic wave equipment is obtained by connecting to a ground the dummy electrode prepared in the location deleted by weighting.

[0181]

Although the electrode finger of the both ends of IDT connected to the balanced signal terminal explained in the sixth gestalt of operation with the configuration which adjoins the ground electrode finger on both sides For example, it also sets in the configuration which adjoins a ground electrode finger at one side, and already adjoins the signal electrode finger at one side like drawing 52 . Decussation width-of-face weighting only of the signal electrode finger of the side which adjoins the ground electrode finger is carried out, and the surface acoustic wave equipment which has improved the amplitude unbalance between balanced signal terminals is obtained by connecting to a ground the dummy electrode prepared in the location deleted by weighting through IDT.

[0182]

Moreover, like drawing 53 , also in the configuration which takes out a balanced signal from the two poles of two or more IDT(s), decussation width-of-face weighting of the outermost electrode finger of each of two IDT(s) is carried out, and the amplitude unbalance between balanced signal terminals can be improved by connecting to a ground the electrode finger by which weighting was carried out through IDT and a reflector.

[0183]

Although the vertical joint resonator mold surface acoustic wave filter explained with a 3IDT type configuration in the sixth gestalt of operation Also for example, in the case of the vertical joint resonator mold surface acoustic wave filter which has four or more IDT(s) The amplitude unbalance between balanced signal terminals is improvable by carrying out decussation width-of-face weighting of the electrode finger of the both ends of IDT which takes out a balanced signal like drawing 54 , and connecting to a ground the dummy electrode prepared in the location deleted by weighting through IDT.

[0184]

(The seventh gestalt of operation)

The seventh gestalt of operation concerning this invention is explained based on drawing 55 thru/or drawing 61 . The seventh gestalt of this operation explains taking the case of the filter for PCS reception.

[0185]

The seventh gestalt of operation is the example which gave weighting to the configuration which does not have the electrical neutrality point which the balanced signal terminal was connected to the sinking comb-like electrode of the two poles of one IDT of one vertical joint resonator mold surface acoustic wave filter, respectively, and was grounded by the ground as well as the third gestalt of operation.

[0186]

With the seventh gestalt of operation, each surface acoustic wave resonators 2902 and 2903 by which series connection was carried out to the vertical joint resonator mold surface acoustic wave filter 2901 and the vertical joint resonator mold surface acoustic wave filter 2901 are formed with aluminum electrode on the above-mentioned piezo-electric substrate 8. The configuration of the seventh gestalt of operation is the same configuration as drawing 29 of the third gestalt of operation fundamentally.

[0187]

The description of the seventh gestalt of operation is the point that duty of the electrode fingers 2919 and 2920 is set to 0.40. Moreover, with the seventh gestalt of operation, the shielding line 2921 connected to the ground is inserted between the signal line 2912 and the balanced signal terminal 2910. Thus, the surface acoustic wave equipment with which a signal inter-electrode bridge capacity was reduced, and the unbalance between balanced signal terminals has been further improved by inserting the shielding line connected to the ground in the part where signal electrodes adjoin each other is obtained.

[0188]

Below, an operation and effectiveness of the seventh gestalt of this operation are explained. Phase unbalance is shown in the amplitude unbalance between the balanced signal terminals to the frequency in the configuration of the seventh gestalt of the operation to drawing 56, and drawing 57. The amplitude unbalance between the balanced signal terminals in the configuration of the example of the second comparison shown in drawing 32 as a comparison and phase unbalance are also shown according to drawing 56 and drawing 57. The configuration of the example of the second comparison of drawing 32 is the completely same configuration except not changing duty of the electrode finger which adjoins IDT 2904 and 2906 of IDT2905 to the seventh gestalt of operation. The frequency range of the passband in the filter for PCS reception is 1930MHz - 1990MHz.

[0189]

Although the deflection of the phase unbalance between the balanced signal terminals in this range has hardly changed in the seventh gestalt and the example of the second comparison of operation, with the seventh gestalt of operation,  $-0.6\text{dB} - +2.0\text{dB}$  (deflection of  $2.6\text{dB}$ ) and about  $0.2\text{dB}$  amplitude unbalance have improved the amplitude unbalance between balanced signal terminals to being  $-0.5\text{dB} - +2.3\text{dB}$  (deflection of  $2.8\text{dB}$ ) in the example of the second comparison.

[0190]

Furthermore, by the example of the second comparison, although + side is large to one of the - sides and the amplitude unbalance and phase unbalance between balanced signal terminals have separated, with the seventh gestalt of operation, the difference of a gap of the direction of + and the direction of - is small. There is a merit that the noise level of an inphase signal becomes small rather than the one where the difference of a gap of the direction of + and the direction of - is smaller has separated greatly in one of + side and the - sides like the seventh gestalt of operation, and the direction of the seventh gestalt of operation is excellent also in this point.

[0191]

The reason the effectiveness of the seventh gestalt of operation was acquired is making smaller than duty of other electrode fingers duty of the electrode finger which adjoins each IDT 2904 and 2906 of IDT2905, and is the effectiveness by having corrected the conversion efficiency between the total capacity of an electrode finger, and an electrical signal and a surface acoustic wave connected to each balanced signal terminals 2910 and 2911.

[0192]

Since especially the difference in the total capacity of this electrode finger etc. is large in the part where two IDT(s) adjoin each other, it is adjusting duty of the electrode finger of this part like the seventh gestalt of operation, and the biggest effectiveness is acquired. What is necessary is just to adjust duty of several electrode fingers near the part where two IDT(s) adjoin each other like drawing 58 , in order to acquire effectiveness furthermore.

[0193]

Next, the amplitude unbalance between the balanced signal terminals to the frequency at the time of making smaller than duty of other electrode fingers duty of the electrode finger (3001 and 3002 of drawing 59 ) which adjoins IDT2905b of IDT2904a and IDT2906a like drawing 59 as another configuration in the seventh gestalt of operation is shown in drawing 60 , and phase unbalance is shown in drawing 61 . At this time,

duty of the electrode finger 3001 and the electrode finger 3002 is set to 0.40.

[0194]

As a comparison, the amplitude unbalance between the balanced signal terminals in the configuration of the example of the second comparison of drawing 32 and phase unbalance are also shown according to drawing 60 and drawing 61. The deflection of the phase unbalance of the balanced signal terminal question in this range Although it has hardly changed in the modification and the example of the second comparison of the seventh gestalt of operation, the amplitude unbalance between balanced signal terminals In the modification of the seventh gestalt of operation, -0.5dB - +2.0dB (deflection of 2.5dB) and about 0.3dB amplitude unbalance have improved to being -0.5dB - +2.3dB (deflection of 2.8dB) in the example of the second comparison.

[0195]

Thus, the effectiveness of this invention is acquired adjusting duty of the electrode finger of IDT connected to the unbalance signal terminal like drawing 59. Even if it can come, of course, and is alike, in addition it adds adjustment of duty to IDT2905b, the effectiveness of this invention is acquired.

[0196]

As mentioned above, as explained, with the seventh gestalt of operation, a balanced signal terminal is connected to the sinking comb-like electrode used as the two poles of IDT of one in [ one vertical joint resonator mold surface acoustic wave filter ], respectively. In the configuration which does not have the electrical neutrality point grounded by the ground, the surface acoustic wave equipment which has improved the amplitude unbalance between balanced signal terminals rather than conventional surface acoustic wave equipment is obtained by carrying out duty weighting of a part of IDT and the part where especially two IDT(s) adjoin each other.

[0197]

(The eighth gestalt of operation)

The eighth gestalt of operation concerning this invention is explained based on drawing 62 thru/or drawing 64. With the eighth gestalt of operation, the configuration of the eighth gestalt of operation is changed with other electrode fingers, for example, is more small, and it not only sets to 0.40 duty of only the electrode finger which adjoins IDT2904 and IDT2906 of IDT2905 like the seventh gestalt of operation, but is setting to 0.40 all dut(ies) of the electrode finger of IDT2905 connected to the balanced signal terminal 2910. All other configurations

are the same as the configuration of the seventh gestalt of operation.

[0198]

Below, an operation and effectiveness of the eighth gestalt of this operation are explained. Phase unbalance is shown in the amplitude unbalance between the balanced signal terminals to the frequency in the configuration of the eighth gestalt of operation, and drawing 64 at drawing 63 . As a comparison, the amplitude unbalance between balanced signal terminals in the configuration of the example of the second comparison shown in drawing 32 and phase unbalance are also shown according to drawing 63 and drawing 64 . Although the phase unbalance between balanced signal terminals is getting worse in the frequency range of the passband of the filter for PCS reception more slightly than the example of the second comparison, about 0.5dB of amplitude unbalance between balanced signal terminals has improved from the example of the second comparison.

[0199]

Furthermore, by the example of the second comparison, although + side is large to one of the - sides and the amplitude unbalance and phase unbalance between balanced signal terminals have separated, with the eighth gestalt of operation, the difference of a gap of the direction of + and the direction of - is small. There is a merit that the noise level of an inphase signal becomes small rather than the one where the difference of a gap of the direction of + and the direction of - is smaller has separated greatly in one of + side and the - sides like the eighth gestalt of operation, and the direction of the eighth gestalt of operation is excellent also in this point.

[0200]

As mentioned above, as explained, with the eighth gestalt of operation, a balanced signal terminal is connected to the sinking comb-like electrode of the two poles of one IDT of one vertical joint resonator mold surface acoustic wave filter, respectively, and it sets in the configuration which does not have the electrical neutrality point grounded by the ground. By carrying out duty weighting of all the electrode fingers [ connecting with one side of a balanced signal terminal ], the surface acoustic wave equipment which has improved the amplitude unbalance between balanced signal terminals rather than conventional surface acoustic wave equipment is obtained.

[0201]

Although the amplitude unbalance between balanced signal terminals is further improvable if all dut(ies) of the electrode finger of IDT2905c connected to the balanced signal terminal 2910 are adjusted like drawing

62 , phase unbalance will get worse conversely. However, like drawing 55 or drawing 58 , all electrode fingers are adjusting only a required number, without adjusting or changing the amount of adjustments of duty for every electrode finger, and it is possible to improve amplitude unbalance, without worsening the phase unbalance between balanced signal terminals.

[0202]

(The ninth gestalt of operation)

The ninth gestalt of operation concerning this invention is explained based on drawing 65 . Although the ninth gestalt of operation is the same configuration as the seventh gestalt of operation fundamentally IDT2904 and IDT2905d make small duty of the electrode finger 3003 of IDT2905d in the part which adjoins each other mutually. In the part where IDT2905d and IDT2906b furthermore adjoin each other, the signal electrode finger besides \*\* of IDT2906b is thinned out, the dummy electrode 3004 connected to the ground was installed in the location lengthened in the meantime, and infanticide weighting is carried out.

[0203]

Next, an operation and effectiveness of the ninth gestalt of this operation are explained. Thus, two kinds of weighting approaches are intermingled in one vertical joint resonator mold surface acoustic wave filter, or the adjustment degree of freedom of the unbalance between balanced signal terminals improves by making some kinds of weighting approaches intermingled further, and the surface acoustic wave equipment with the unbalance between desired balanced signal terminals which has a balanced signal terminal is obtained.

[0204]

With each gestalt of the above operation, as for this invention, the same effectiveness is acquired not only with this substrate but with substrates, such as the 64-72-degreeYcutX propagation LiNbO<sub>3</sub> and the 41-degreeYcutX propagation LiNbO<sub>3</sub>, as the principle from which effectiveness is acquired also shows as a piezo-electric substrate, although 40 \*\*5-degreeYcutX propagation LiTaO<sub>3</sub> substrate was used.

[0205]

Moreover, it is desirable to carry out weighting in the direction in which excitation of a surface acoustic wave becomes strong to the electrode finger of a surface acoustic wave filter in the surface acoustic wave equipment which has balanced - unbalance conversion function using two surface acoustic wave filters equipped with three or more IDT(s). While this controls that pass band width becomes narrow, the amplitude unbalance in a passband is improvable.

[0206]

As an example of weighting of the direction where excitation of such a surface acoustic wave becomes strong, weighting is not carried out to one surface acoustic wave equipment (1st surface acoustic wave equipment), but giving infanticide weighting, decussation weighting (formation of a dummy electrode also being included), or serial weighting (the most desirable) is mentioned to the both sides of the outermost electrode finger (desirably signal electrode finger) of IDT of the center of the surface acoustic wave equipment (2nd surface acoustic wave equipment) of another side.

[0207]

Furthermore, although each gestalt of the above-mentioned operation explained respectively various weighting, they are equipped with the operation and effectiveness which carried out mutually-independent, and even if it uses combining them how, they can acquire the effectiveness of the invention in this application two or more.

[0208]

It is as follows when a carrying-in each gestalt of the above-mentioned operation concerning this invention-surface acoustic wave equipment of publication communication device is explained based on drawing 66 . As shown in drawing 66 , the transmitter 3100 carrying surface acoustic wave equipment given in the ninth any [ the first of operation thru/or ] they are As a receiver side (Rx side) which receives An antenna 3101, the antenna common section / RFTop filter 3102, amplifier 3103, Rx interstage filter 3104, a mixer 3105, the 1stIF filter 3106, a mixer 3107, the 2ndIF filter 3108, the 1st+2nd local synthesizer 3111, It has TCXO (Temperature Compensated crystal Oscillator (temperature-compensated crystal oscillator))3112, a divider 3113, and the local filter 3114, and is constituted. As double lines showed, in order to secure the unbalance between balanced signal terminals from Rx interstage filter 3104 in drawing 66 to a mixer 3105, transmitting by each balanced signal is desirable.

[0209]

Moreover, as a transceiver side (Tx side) which transmits, it has the TxIF filter 3121, a mixer 3122, Tx interstage filter 3123, amplifier 3124, a coupler 3125, an isolator 3126, and APC (Automatic Power Control (APC))3127, and the above-mentioned communication device 3100 is constituted while sharing the above-mentioned antenna 3101, and the above-mentioned above-mentioned antenna common section / RFTop filter 3102.

[0210]

And surface acoustic wave equipment given in any of the first of operation thru/or the ninth gestalt mentioned above they are can use for the above-mentioned Rx interstage filter 3104 suitably.

[0211]

Therefore, the above-mentioned communication device 3100 is the thing excellent in the transmission characteristic (communication link engine performance), attaining a miniaturization more than a miniaturization, especially a GHz band, since it excels in the transmission characteristic while the used surface acoustic wave equipment attains a miniaturization.

[0212]

[Effect of the Invention]

IDT for an input to which the surface acoustic wave equipment of this invention has two or more electrode fingers on a piezo-electric substrate as mentioned above, IDT for an output which has two or more electrode fingers is prepared along the propagation direction of a surface acoustic wave so that a vertical joint resonator mold may be formed. Either said IDT for an input or IDT for an output It is an object for a balance and is the configuration of having the weighting electrode finger by which weighting was carried out to a different inside electrode finger from the outermost electrode finger of one [ at least ] electrode finger of each of the balancing side.

[0213]

So, with the above-mentioned configuration, the effectiveness that the unbalance of the balancing side is improvable is done by having the weighting electrode finger by which weighting was carried out to a different inside electrode finger from the outermost electrode finger of one [ at least ] electrode finger of each of the balancing side.

[0214]

Other surface acoustic wave equipments of this invention the surface acoustic wave filter which has at least two IDT(s) formed along the propagation direction of a surface acoustic wave on the piezo-electric substrate as mentioned above At least one It is surface acoustic wave equipment equipped with the input signal terminal and output signal terminal for the above-mentioned surface acoustic wave filter. Either [ at least ] an input signal terminal or an output signal terminal is the configuration by which decussation width-of-face weighting is carried out that connect with the balanced signal terminal and electrode fingers other than an outermost electrode finger in Above IDT change the decussation width of face of an electrode finger with other electrode fingers.

[0215]

So, the effectiveness that the above-mentioned configuration can improve the balancing (balance nature) for example, between each balanced terminal by [ in which electrode fingers other than an outermost electrode finger in Above IDT change the decapsulation width of face of an electrode finger with other electrode fingers ] carrying out decapsulation width-of-face weighting is done.

[0216]

In at least one side of IDT which the surface acoustic wave equipment of further others of this invention adjoins mutually as mentioned above In at least one side of IDT which duty weighting which changes duty of the outermost electrode finger of the part where Above IDT adjoins each other mutually with other electrode fingers is given, and is different and which adjoins each other mutually While Above IDT thins out and weighting is carried out to the outermost electrode finger of the part which adjoins each other mutually, it is the configuration that the dummy electrode connected to the bus bar to which the electrode finger by which infanticide weighting was carried out [ above-mentioned ] was connected, and the opposite bus bar which counters is prepared in the part by which infanticide weighting was carried out [ above-mentioned ].

[0217]

So, the above-mentioned configuration does the effectiveness that the balancing (balance nature) between each balanced terminal is improvable, by having given duty weighting and infanticide weighting and having prepared the dummy electrode.

[0218]

The communication device of this invention is characterized by using the above-mentioned surface acoustic wave equipment as mentioned above.

[0219]

So, the above-mentioned configuration does the effectiveness of excelling in a transmission characteristic (communication link engine performance), attaining a miniaturization more than a miniaturization, especially a GHz band.

[Brief Description of the Drawings]

[Drawing 1] It is the important section block diagram of the surface acoustic wave equipment concerning the first gestalt of operation of this invention.

[Drawing 2] It is the explanatory view showing the important section configuration of the surface acoustic wave equipment of the example of the first comparison.

[Drawing 3] It is the important section block diagram of the surface

acoustic wave equipment concerning the example of a complete-change form of the first gestalt of the above-mentioned implementation.

[Drawing 4] It is an important section block diagram for explaining the weighting field in the surface acoustic wave equipment of the first gestalt of the above-mentioned implementation.

[Drawing 5] It is the graph which shows the amplitude balancing (amplitude balance) of the above-mentioned surface acoustic wave equipment.

[Drawing 6] It is the graph which shows the phase balancing (phase balance) of the above-mentioned surface acoustic wave equipment.

[Drawing 7] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment of the above-mentioned example of the first comparison.

[Drawing 8] It is the graph which shows the phase balancing (phase balance) of the surface acoustic wave equipment of the above-mentioned example of the first comparison.

[Drawing 9] It is the important section block diagram of the surface acoustic wave equipment concerning other modifications in the first gestalt of the above-mentioned implementation.

[Drawing 10] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 11] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 12] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 13] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 14] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 15] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 16] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 17] It is the important section block diagram of the surface

acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 18] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 19] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 20] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 21] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 22] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 23] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 24] It is the important section block diagram of the surface acoustic wave equipment concerning the second gestalt of operation of this invention.

[Drawing 25] It is the graph which shows the amplitude balancing (amplitude balance) of the above-mentioned surface acoustic wave equipment.

[Drawing 26] It is the graph which shows the phase balance of the above-mentioned surface acoustic wave equipment.

[Drawing 27] It is the graph which shows the transmission characteristic of the surface acoustic wave equipment concerning the first gestalt of the above-mentioned implementation.

[Drawing 28] It is the graph which shows the transmission characteristic of the surface acoustic wave equipment concerning the second gestalt of the above-mentioned implementation.

[Drawing 29] It is the important section block diagram of the surface acoustic wave equipment concerning the third gestalt of operation of this invention.

[Drawing 30] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning the third gestalt and the example of the second comparison of the above-mentioned implementation.

[Drawing 31] It is the graph which shows the phase balance of the surface acoustic wave equipment concerning the third gestalt and the example of the second comparison of the above-mentioned implementation.

[Drawing 32] It is the important section block diagram of the surface acoustic wave equipment concerning the above-mentioned example of the second comparison.

[Drawing 33] It is the important section block diagram of the surface acoustic wave equipment concerning the fourth gestalt of operation of this invention.

[Drawing 34] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning the fourth gestalt and the second conventional example of the above-mentioned implementation.

[Drawing 35] It is an important section block diagram to show balance degradation in the above-mentioned second conventional example.

[Drawing 36] It is an important section block diagram to show the balance improvement in the fourth gestalt of the above-mentioned implementation.

[Drawing 37] It is the important section block diagram of the surface acoustic wave equipment of the example of a complete-change form in the fourth gestalt of the above-mentioned implementation.

[Drawing 38] It is an important section block diagram to show the balance improvement in the example of a complete-change form of the fourth gestalt of the above-mentioned implementation.

[Drawing 39] It is the important section block diagram of the surface acoustic wave equipment which is other modifications in the fourth gestalt of the above-mentioned implementation.

[Drawing 40] It is an important section block diagram to show the balance improvement in other modifications in the fourth gestalt of the above-mentioned implementation.

[Drawing 41] It is the important section block diagram of the surface acoustic wave equipment which is the modification of others [ pan / in the fourth gestalt of the above-mentioned implementation ].

[Drawing 42] It is the important section block diagram of the surface acoustic wave equipment concerning the fifth gestalt of operation of this invention.

[Drawing 43] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning the fifth gestalt and the example of the third comparison of the above-mentioned implementation.

[Drawing 44] It is the important section block diagram of the surface

acoustic wave equipment concerning the above-mentioned example of the third comparison.

[Drawing 45] It is an important section block diagram to show balance degradation in the above-mentioned example of the third comparison.

[Drawing 46] It is an important section block diagram to show the balance improvement in the fifth gestalt of the above-mentioned implementation.

[Drawing 47] It is the important section block diagram of the surface acoustic wave equipment concerning the sixth gestalt of operation of this invention.

[Drawing 48] It is the important section expansion block diagram of the surface acoustic wave equipment concerning the sixth gestalt of the above-mentioned implementation.

[Drawing 49] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning the sixth gestalt and the example of the fourth comparison of the above-mentioned implementation.

[Drawing 50] It is the important section block diagram of the surface acoustic wave equipment concerning the above-mentioned example of the fourth comparison.

[Drawing 51] It is the graph which shows the change of the amplitude balancing (amplitude balance) accompanying change of decussation width of face in the surface acoustic wave equipment concerning the sixth gestalt of the above-mentioned implementation.

[Drawing 52] It is the important section block diagram of the surface acoustic wave equipment concerning the example of a complete-change form of the sixth gestalt of the above-mentioned implementation.

[Drawing 53] It is the important section block diagram of the surface acoustic wave equipment concerning other modifications in the sixth gestalt of the above-mentioned implementation.

[Drawing 54] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the sixth gestalt of the above-mentioned implementation at other modifications.

[Drawing 55] It is the important section block diagram of the surface acoustic wave equipment concerning the seventh gestalt of operation of this invention.

[Drawing 56] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning the seventh gestalt and the example of the second comparison of the above-mentioned implementation.

[Drawing 57] It is the graph which shows the phase balance of the

surface acoustic wave equipment concerning the seventh gestalt and the example of the second comparison of the above-mentioned implementation.

[Drawing 58] It is the important section block diagram of the surface acoustic wave equipment concerning the example of a complete-change form of the seventh gestalt of the above-mentioned implementation.

[Drawing 59] It is the important section block diagram of the surface acoustic wave equipment concerning other modifications in the seventh gestalt of the above-mentioned implementation.

[Drawing 60] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning other modifications in the seventh gestalt of the above-mentioned implementation, and the example of the second comparison.

[Drawing 61] It is the graph which shows the phase balance of the surface acoustic wave equipment concerning other modifications in the seventh gestalt of the above-mentioned implementation, and the example of the second comparison.

[Drawing 62] It is the important section block diagram of the surface acoustic wave equipment concerning the eighth gestalt of operation of this invention.

[Drawing 63] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning the eighth gestalt and the example of the second comparison of the above-mentioned implementation.

[Drawing 64] It is the graph which shows the phase balance of the surface acoustic wave equipment concerning the eighth gestalt and the example of the second comparison of the above-mentioned implementation.

[Drawing 65] It is the important section block diagram of the surface acoustic wave equipment concerning the ninth gestalt of operation of this invention.

[Drawing 66] It is the important section block diagram of the communication device of this invention.

[Drawing 67] It is the important section block diagram of the surface acoustic wave equipment of the first conventional example.

[Drawing 68] It is the important section block diagram of the surface acoustic wave equipment of the second conventional example.

[Drawing 69] It is a graph to show the difference in the insertion loss between the balanced signal terminals in the former.

[Drawing 70] It is the important section block diagram of one surface acoustic wave equipment to show the difference in the insertion loss between the balanced signal terminals in the above-mentioned former.

[Drawing 71] It is the important section block diagram of the surface

acoustic wave equipment of another side to show the difference in the insertion loss between the balanced signal terminals in the above-mentioned former.

[Drawing 72] Explaining the resonance mode in surface acoustic wave equipment, (a) is a graph which shows the frequency relation of resonance mode, and (b) is the graph of the current distribution corresponding to the outline block diagram and it which show active current distribution of resonance mode.

[Drawing 73] It is the important section block diagram of the surface acoustic wave equipment of the third conventional example.

[Description of Notations]

1 IDT (Comb Mold Polar Zone)

2 IDT (Comb Mold Polar Zone)

3 IDT (Comb Mold Polar Zone)

22 Signal Electrode Finger (Inside Electrode Finger)

21a Dummy electrode

22a Decussation weighting electrode finger (weighting electrode finger)

31a Dummy electrode

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[Translation done.]

\* NOTICES \*

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is the important section block diagram of the surface acoustic wave equipment concerning the first gestalt of operation of this invention.

[Drawing 2] It is the explanatory view showing the important section configuration of the surface acoustic wave equipment of the example of the first comparison.

[Drawing 3] It is the important section block diagram of the surface

acoustic wave equipment concerning the example of a complete-change form of the first gestalt of the above-mentioned implementation.

[Drawing 4] It is an important section block diagram for explaining the weighting field in the surface acoustic wave equipment of the first gestalt of the above-mentioned implementation.

[Drawing 5] It is the graph which shows the amplitude balancing (amplitude balance) of the above-mentioned surface acoustic wave equipment.

[Drawing 6] It is the graph which shows the phase balancing (phase balance) of the above-mentioned surface acoustic wave equipment.

[Drawing 7] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment of the above-mentioned example of the first comparison.

[Drawing 8] It is the graph which shows the phase balancing (phase balance) of the surface acoustic wave equipment of the above-mentioned example of the first comparison.

[Drawing 9] It is the important section block diagram of the surface acoustic wave equipment concerning other modifications in the first gestalt of the above-mentioned implementation.

[Drawing 10] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 11] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 12] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

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[Drawing 20] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 21] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 22] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 23] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the first gestalt of the above-mentioned implementation at other modifications.

[Drawing 24] It is the important section block diagram of the surface acoustic wave equipment concerning the second gestalt of operation of this invention.

[Drawing 25] It is the graph which shows the amplitude balancing (amplitude balance) of the above-mentioned surface acoustic wave equipment.

[Drawing 26] It is the graph which shows the phase balance of the above-mentioned surface acoustic wave equipment.

[Drawing 27] It is the graph which shows the transmission characteristic of the surface acoustic wave equipment concerning the first gestalt of the above-mentioned implementation.

[Drawing 28] It is the graph which shows the transmission characteristic of the surface acoustic wave equipment concerning the second gestalt of the above-mentioned implementation.

[Drawing 29] It is the important section block diagram of the surface acoustic wave equipment concerning the third gestalt of operation of this invention.

[Drawing 30] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning the third gestalt and the example of the second comparison of the above-mentioned implementation.

[Drawing 31] It is the graph which shows the phase balance of the surface acoustic wave equipment concerning the third gestalt and the example of the second comparison of the above-mentioned implementation.

[Drawing 32] It is the important section block diagram of the surface acoustic wave equipment concerning the above-mentioned example of the second comparison.

[Drawing 33] It is the important section block diagram of the surface acoustic wave equipment concerning the fourth gestalt of operation of this invention.

[Drawing 34] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning the fourth gestalt and the second conventional example of the above-mentioned implementation.

[Drawing 35] It is an important section block diagram to show balance degradation in the above-mentioned second conventional example.

[Drawing 36] It is an important section block diagram to show the balance improvement in the fourth gestalt of the above-mentioned implementation.

[Drawing 37] It is the important section block diagram of the surface acoustic wave equipment of the example of a complete-change form in the fourth gestalt of the above-mentioned implementation.

[Drawing 38] It is an important section block diagram to show the balance improvement in the example of a complete-change form of the fourth gestalt of the above-mentioned implementation.

[Drawing 39] It is the important section block diagram of the surface acoustic wave equipment which is other modifications in the fourth gestalt of the above-mentioned implementation.

[Drawing 40] It is an important section block diagram to show the balance improvement in other modifications in the fourth gestalt of the above-mentioned implementation.

[Drawing 41] It is the important section block diagram of the surface acoustic wave equipment which is the modification of others [ pan / in the fourth gestalt of the above-mentioned implementation ].

[Drawing 42] It is the important section block diagram of the surface acoustic wave equipment concerning the fifth gestalt of operation of this invention.

[Drawing 43] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning the fifth gestalt and the example of the third comparison of the above-mentioned implementation.

[Drawing 44] It is the important section block diagram of the surface

acoustic wave equipment concerning the above-mentioned example of the third comparison.

[Drawing 45] It is an important section block diagram to show balance degradation in the above-mentioned example of the third comparison.

[Drawing 46] It is an important section block diagram to show the balance improvement in the fifth gestalt of the above-mentioned implementation.

[Drawing 47] It is the important section block diagram of the surface acoustic wave equipment concerning the sixth gestalt of operation of this invention.

[Drawing 48] It is the important section expansion block diagram of the surface acoustic wave equipment concerning the sixth gestalt of the above-mentioned implementation.

[Drawing 49] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning the sixth gestalt and the example of the fourth comparison of the above-mentioned implementation.

[Drawing 50] It is the important section block diagram of the surface acoustic wave equipment concerning the above-mentioned example of the fourth comparison.

[Drawing 51] It is the graph which shows the change of the amplitude balancing (amplitude balance) accompanying change of decussation width of face in the surface acoustic wave equipment concerning the sixth gestalt of the above-mentioned implementation.

[Drawing 52] It is the important section block diagram of the surface acoustic wave equipment concerning the example of a complete-change form of the sixth gestalt of the above-mentioned implementation.

[Drawing 53] It is the important section block diagram of the surface acoustic wave equipment concerning other modifications in the sixth gestalt of the above-mentioned implementation.

[Drawing 54] It is the important section block diagram of the surface acoustic wave equipment applied to the pan in the sixth gestalt of the above-mentioned implementation at other modifications.

[Drawing 55] It is the important section block diagram of the surface acoustic wave equipment concerning the seventh gestalt of operation of this invention.

[Drawing 56] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning the seventh gestalt and the example of the second comparison of the above-mentioned implementation.

[Drawing 57] It is the graph which shows the phase balance of the

surface acoustic wave equipment concerning the seventh gestalt and the example of the second comparison of the above-mentioned implementation.

[Drawing 58] It is the important section block diagram of the surface acoustic wave equipment concerning the example of a complete-change form of the seventh gestalt of the above-mentioned implementation.

[Drawing 59] It is the important section block diagram of the surface acoustic wave equipment concerning other modifications in the seventh gestalt of the above-mentioned implementation.

[Drawing 60] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning other modifications in the seventh gestalt of the above-mentioned implementation, and the example of the second comparison.

[Drawing 61] It is the graph which shows the phase balance of the surface acoustic wave equipment concerning other modifications in the seventh gestalt of the above-mentioned implementation, and the example of the second comparison.

[Drawing 62] It is the important section block diagram of the surface acoustic wave equipment concerning the eighth gestalt of operation of this invention.

[Drawing 63] It is the graph which shows the amplitude balancing (amplitude balance) of the surface acoustic wave equipment concerning the eighth gestalt and the example of the second comparison of the above-mentioned implementation.

[Drawing 64] It is the graph which shows the phase balance of the surface acoustic wave equipment concerning the eighth gestalt and the example of the second comparison of the above-mentioned implementation.

[Drawing 65] It is the important section block diagram of the surface acoustic wave equipment concerning the ninth gestalt of operation of this invention.

[Drawing 66] It is the important section block diagram of the communication device of this invention.

[Drawing 67] It is the important section block diagram of the surface acoustic wave equipment of the first conventional example.

[Drawing 68] It is the important section block diagram of the surface acoustic wave equipment of the second conventional example.

[Drawing 69] It is a graph to show the difference in the insertion loss between the balanced signal terminals in the former.

[Drawing 70] It is the important section block diagram of one surface acoustic wave equipment to show the difference in the insertion loss between the balanced signal terminals in the above-mentioned former.

[Drawing 71] It is the important section block diagram of the surface

acoustic wave equipment of another side to show the difference in the insertion loss between the balanced signal terminals in the above-mentioned former.

[Drawing 72] Explaining the resonance mode in surface acoustic wave equipment, (a) is a graph which shows the frequency relation of resonance mode, and (b) is the graph of the current distribution corresponding to the outline block diagram and it which show active current distribution of resonance mode.

[Drawing 73] It is the important section block diagram of the surface acoustic wave equipment of the third conventional example.

[Description of Notations]

1 IDT (Comb Mold Polar Zone)

2 IDT (Comb Mold Polar Zone)

3 IDT (Comb Mold Polar Zone)

22 Signal Electrode Finger (Inside Electrode Finger)

21a Dummy electrode

22a Decussation weighting electrode finger (weighting electrode finger)

31a Dummy electrode

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[Translation done.]

\* NOTICES \*

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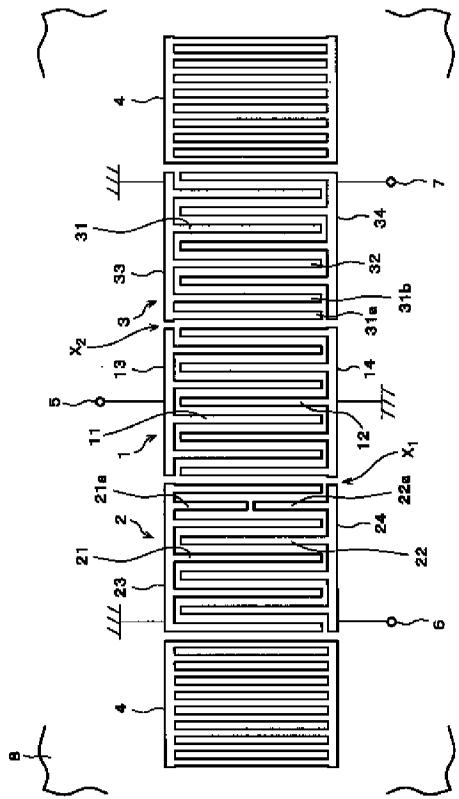
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

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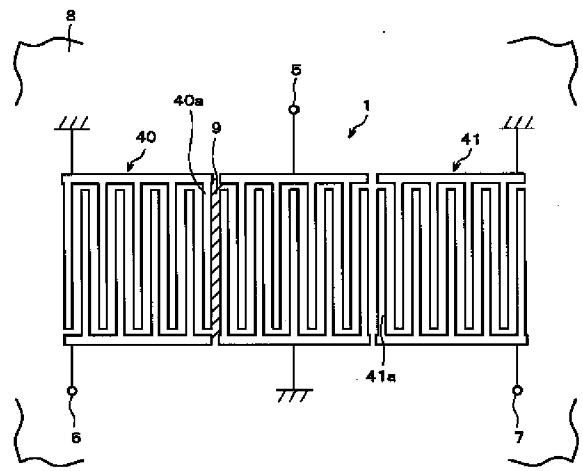
DRAWINGS

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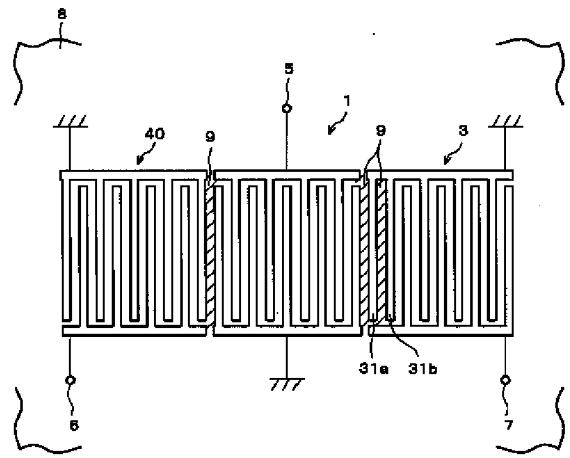
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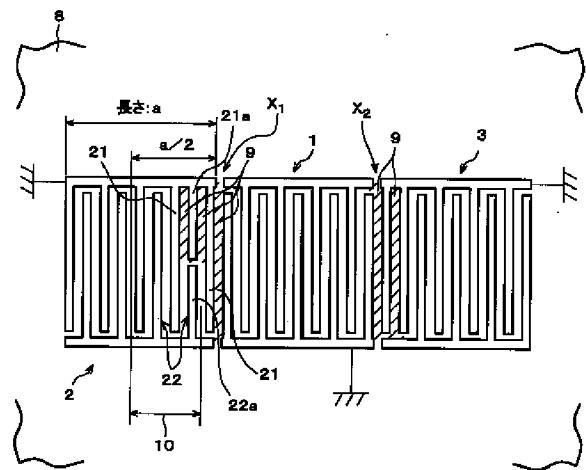
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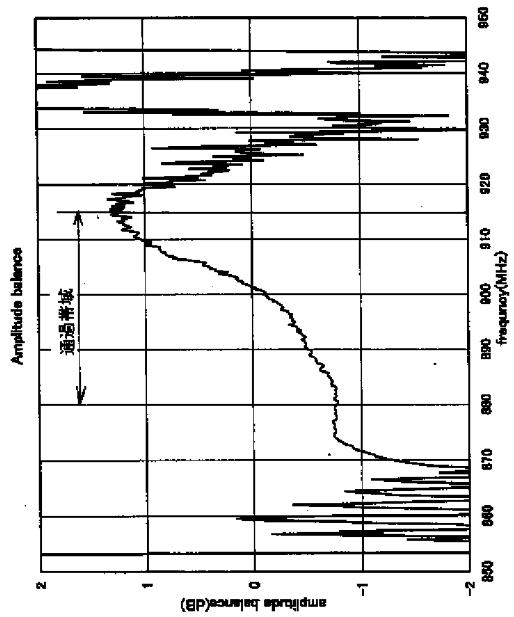
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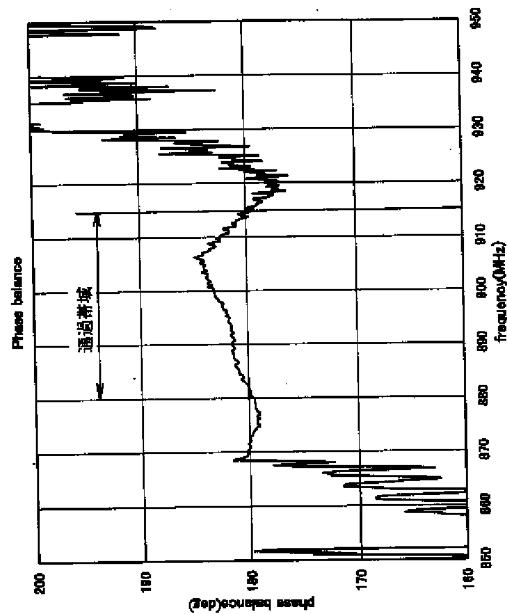
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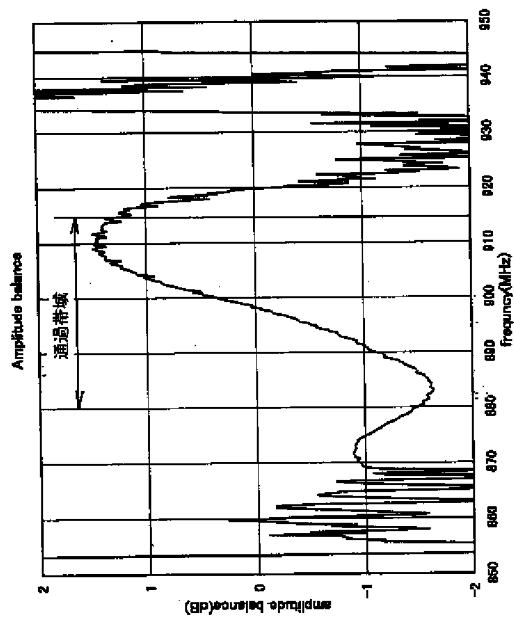
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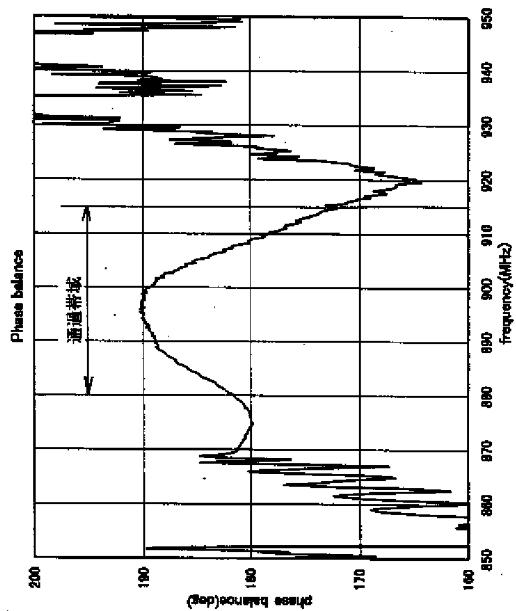
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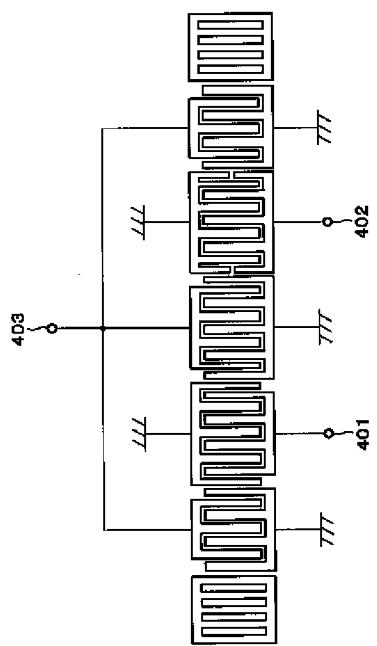
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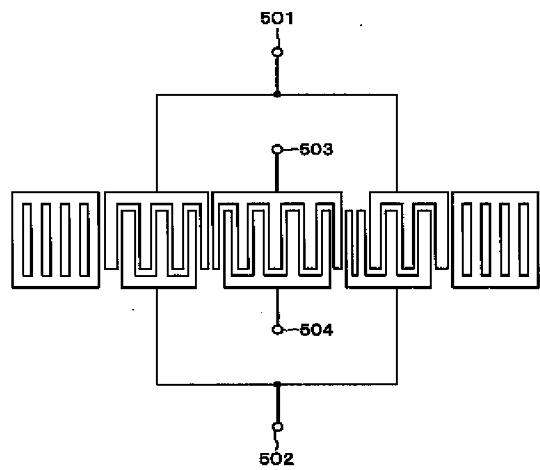
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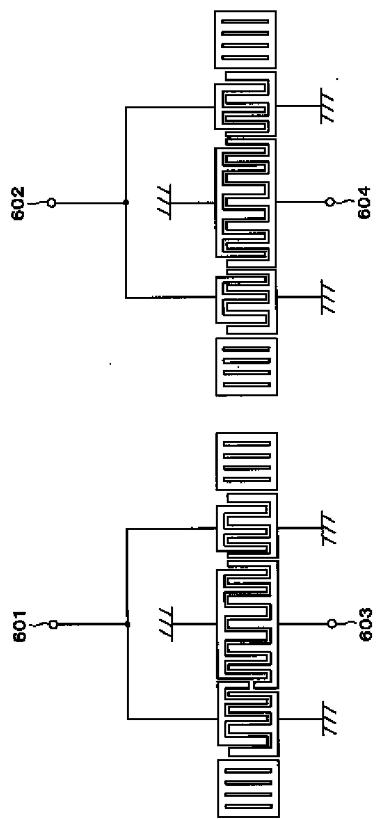
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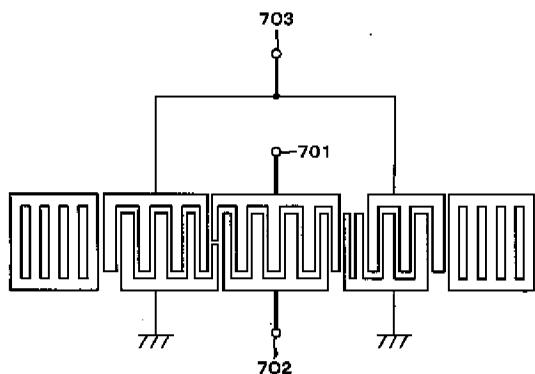
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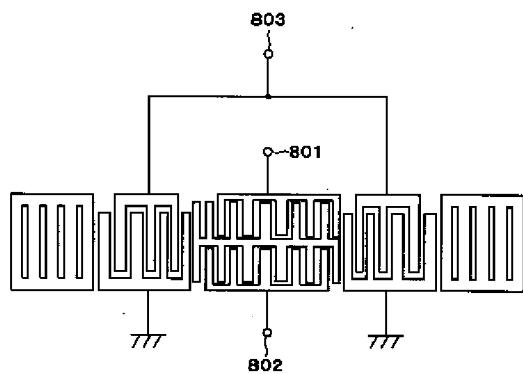
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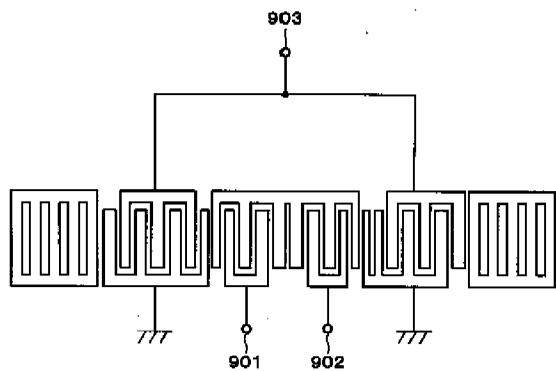
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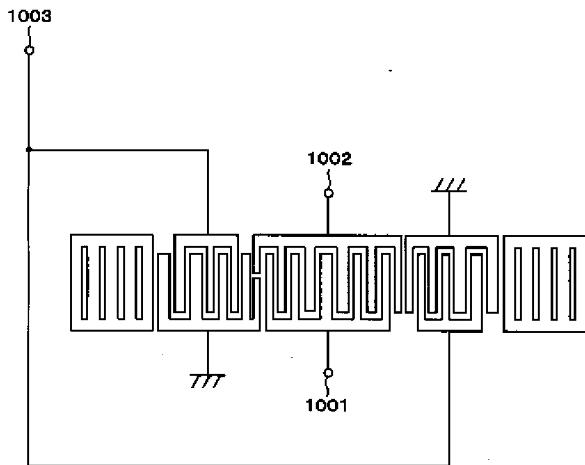
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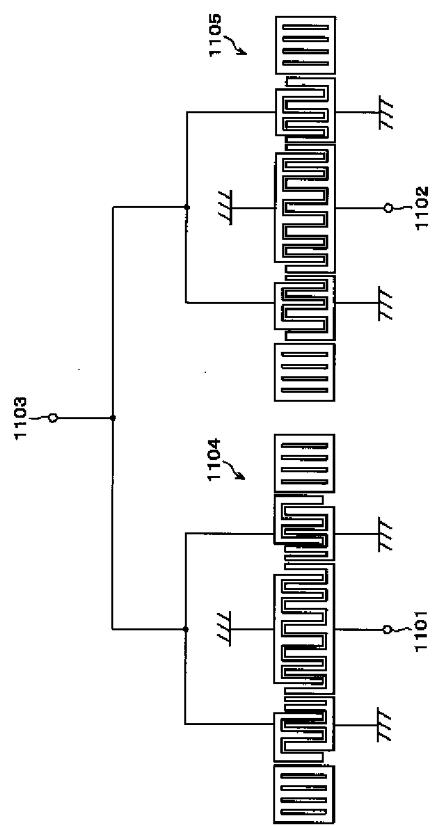
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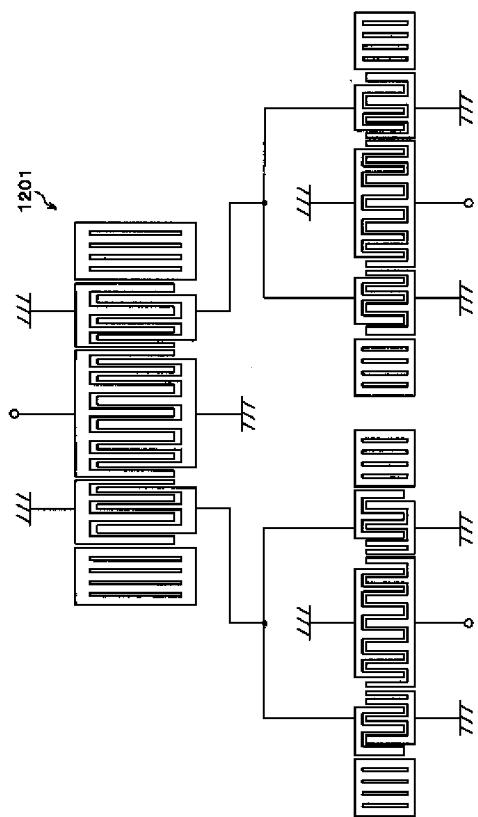
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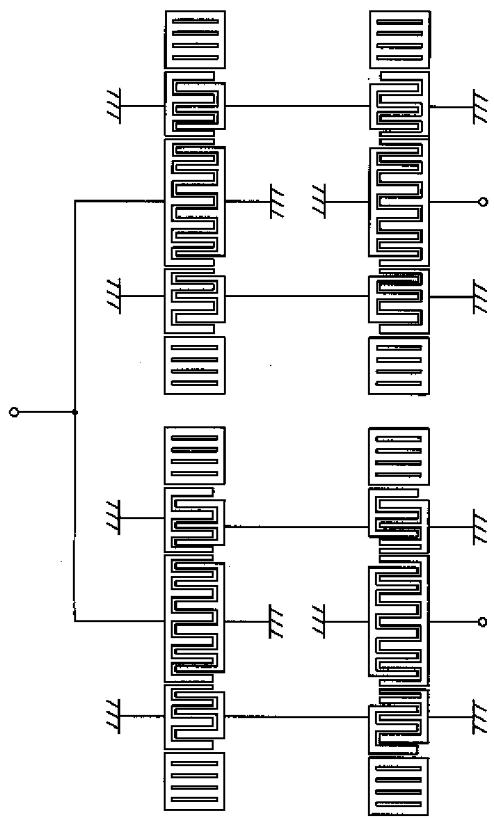
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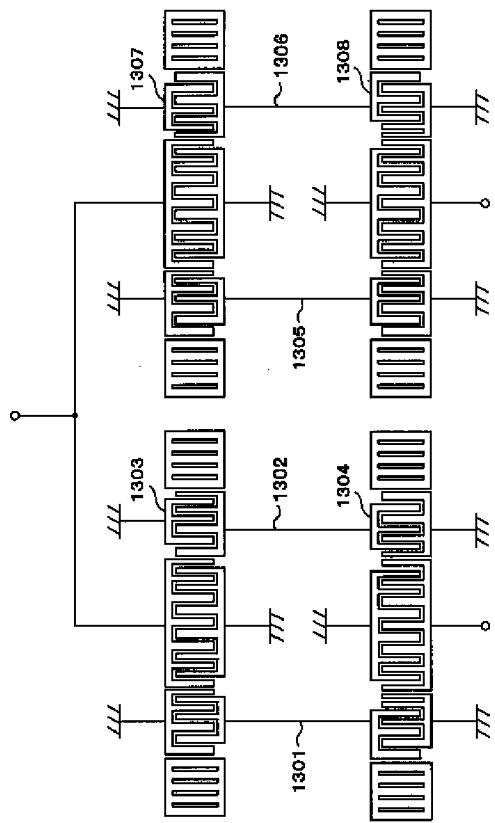
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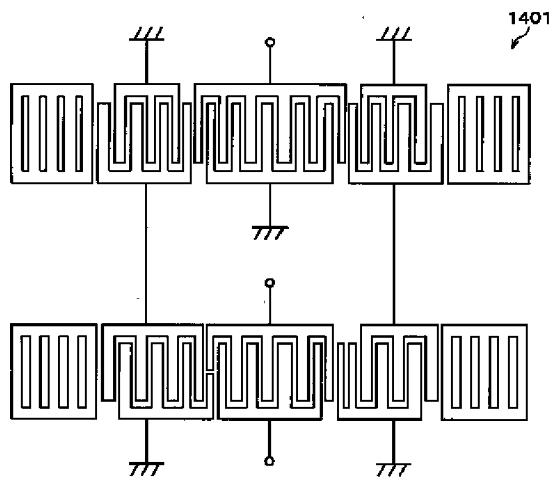
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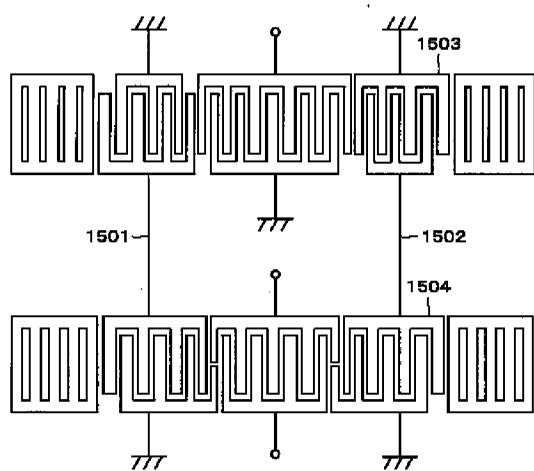
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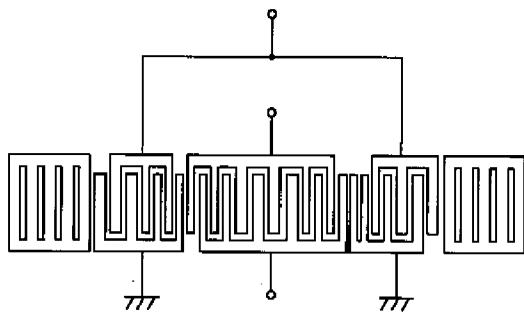
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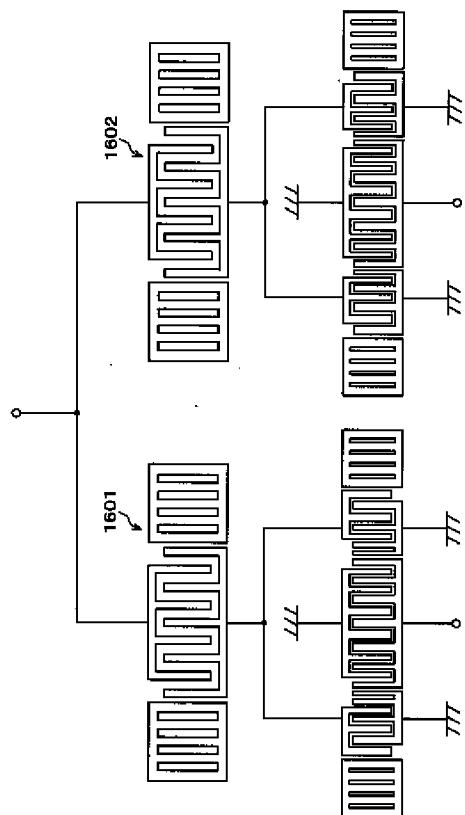
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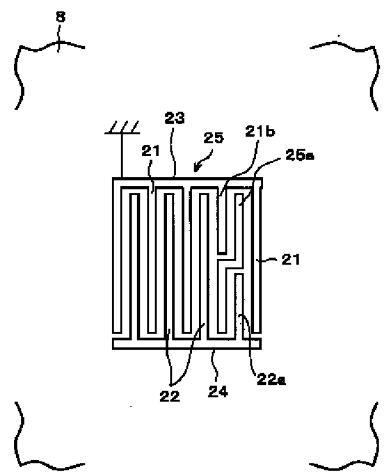
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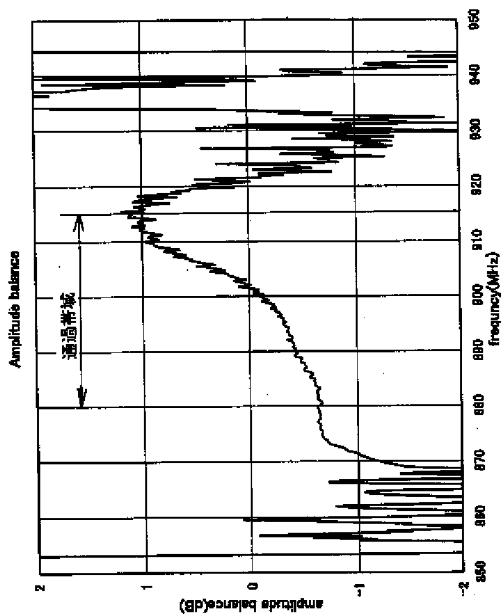
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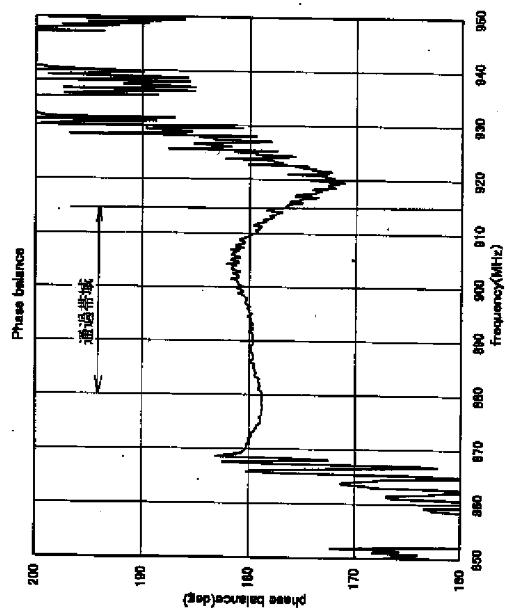
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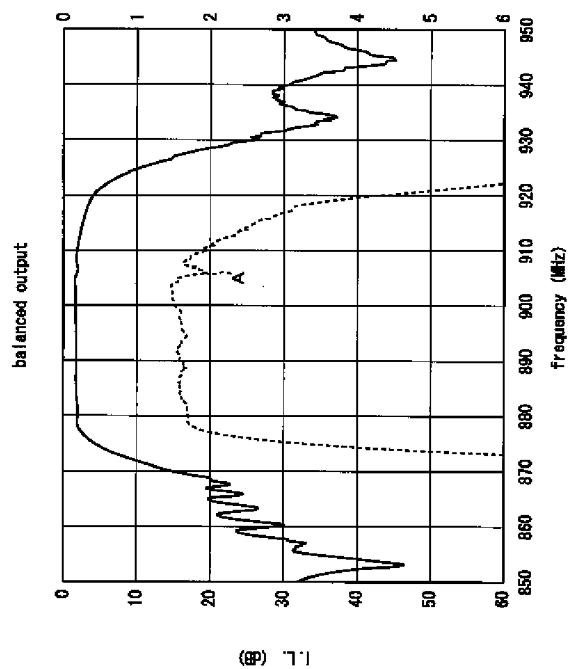
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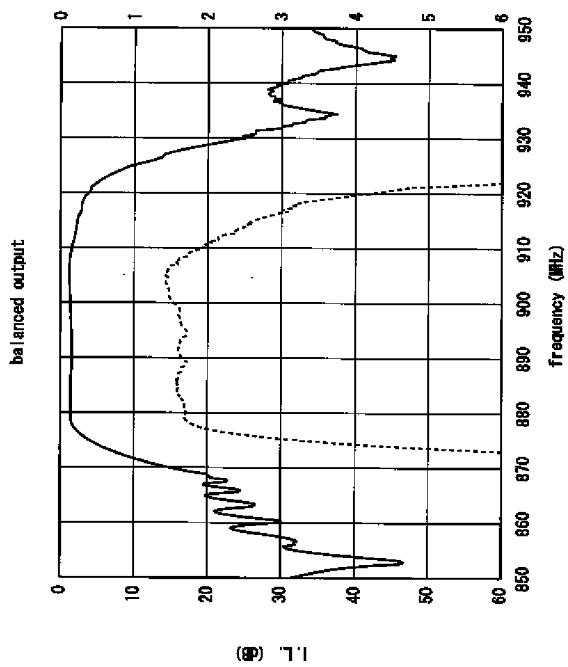
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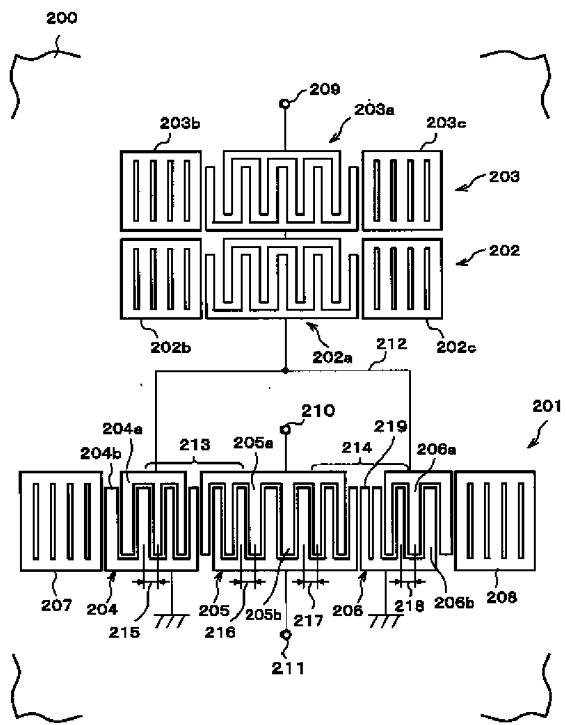
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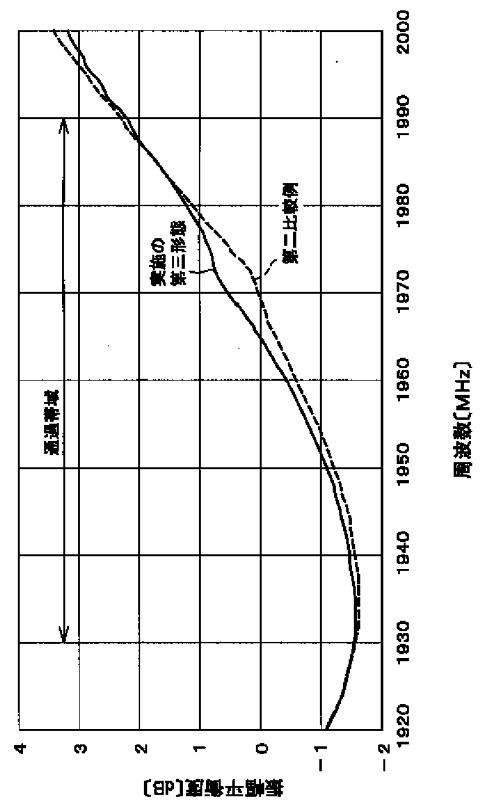
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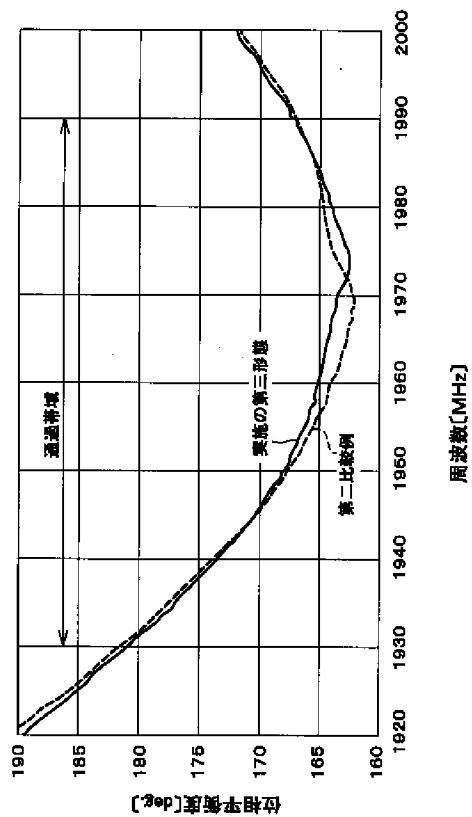
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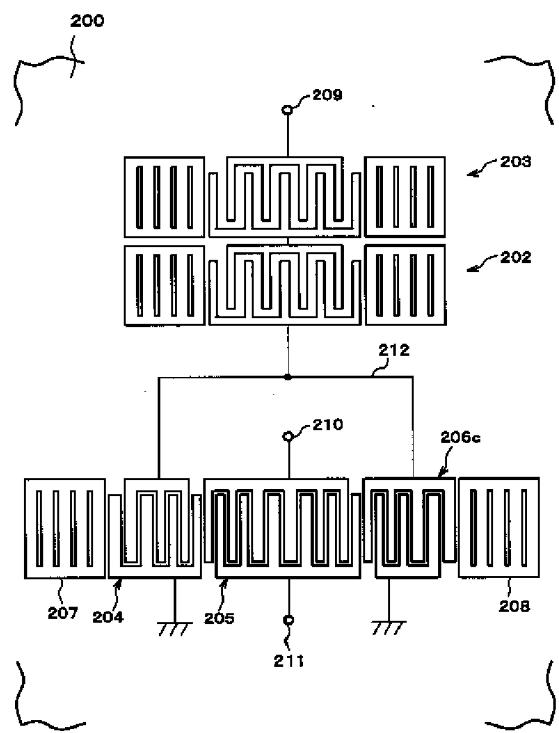
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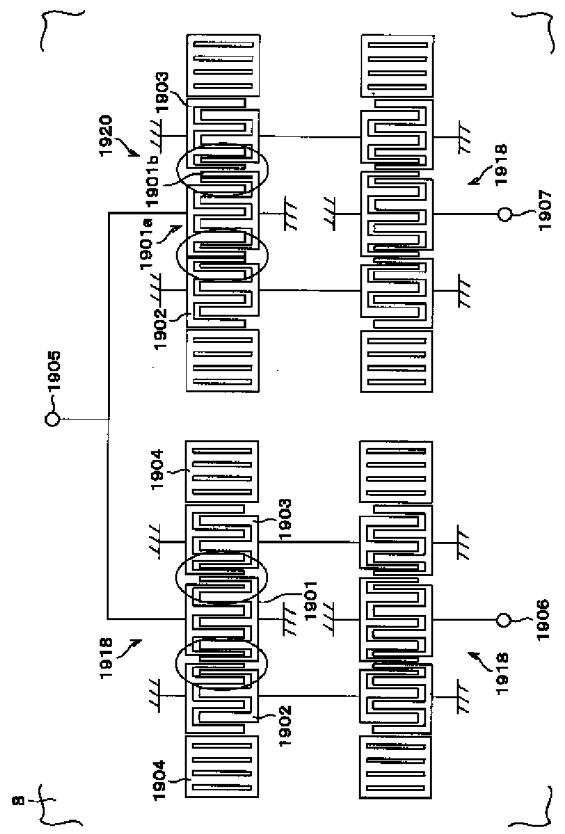
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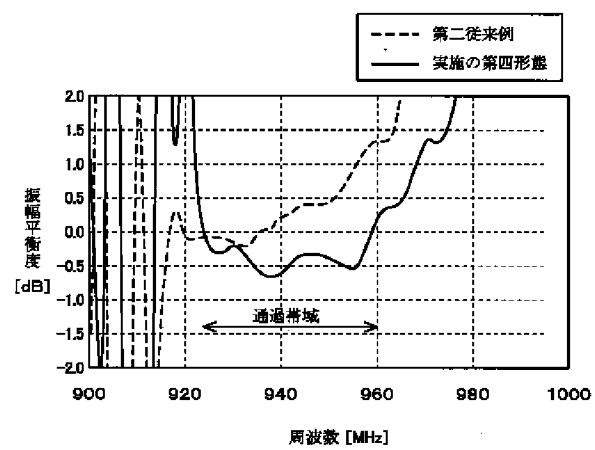
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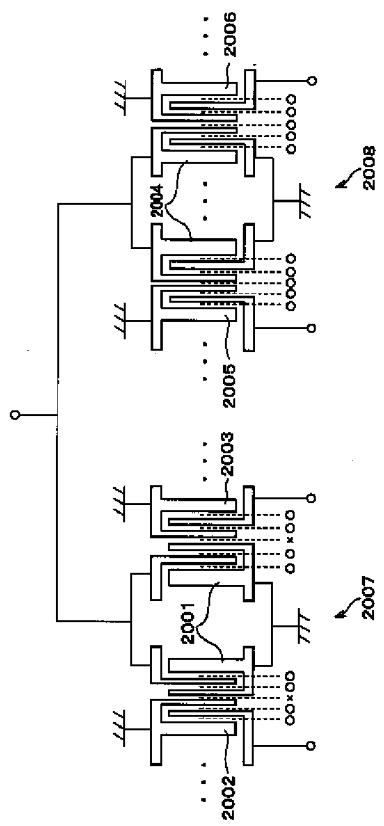
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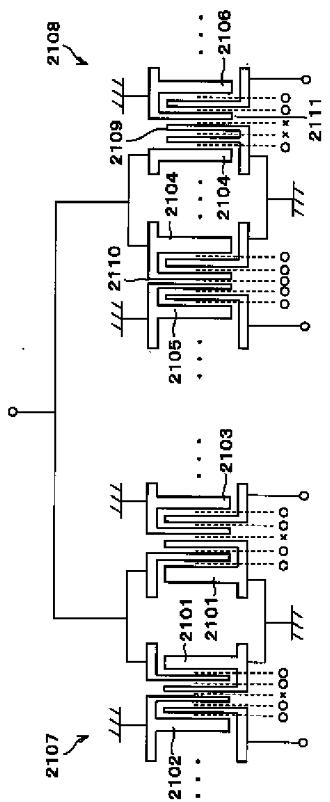
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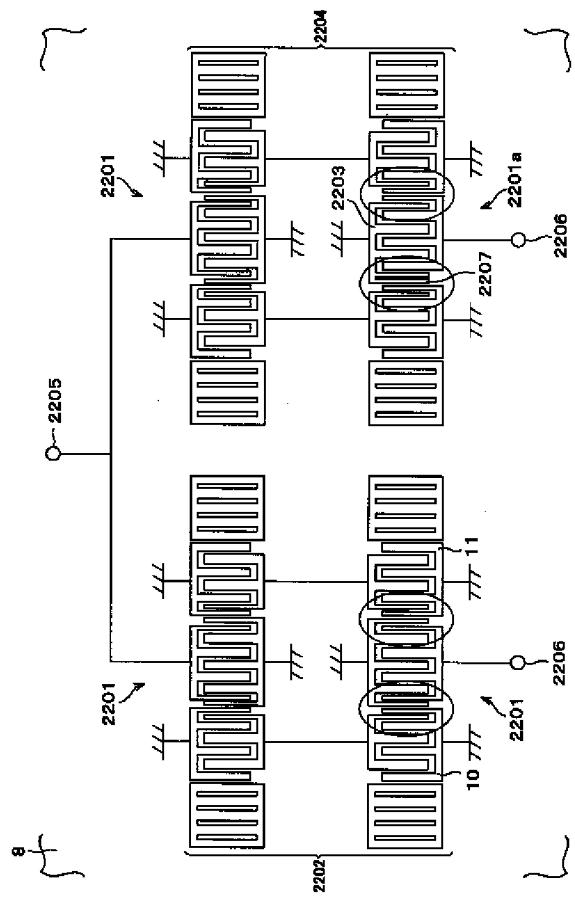
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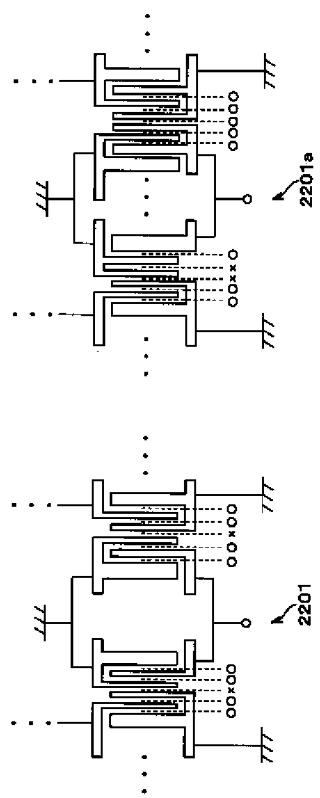
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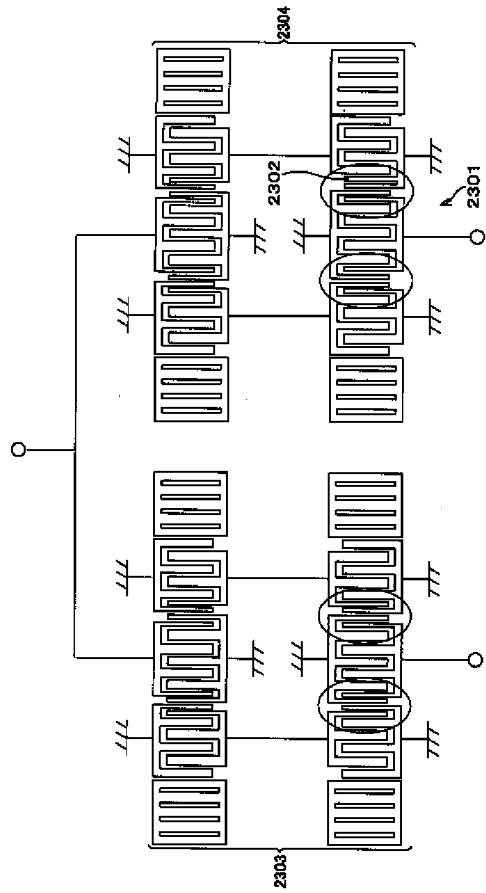
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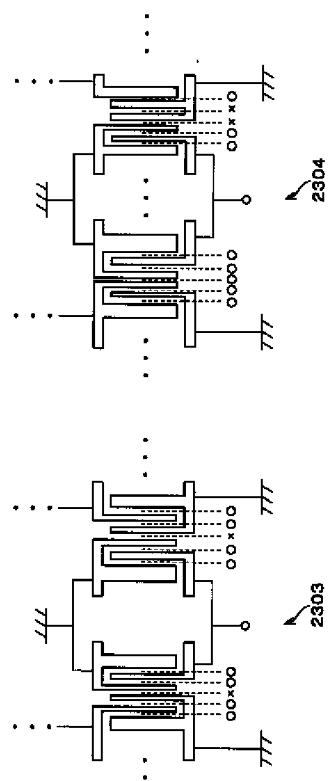
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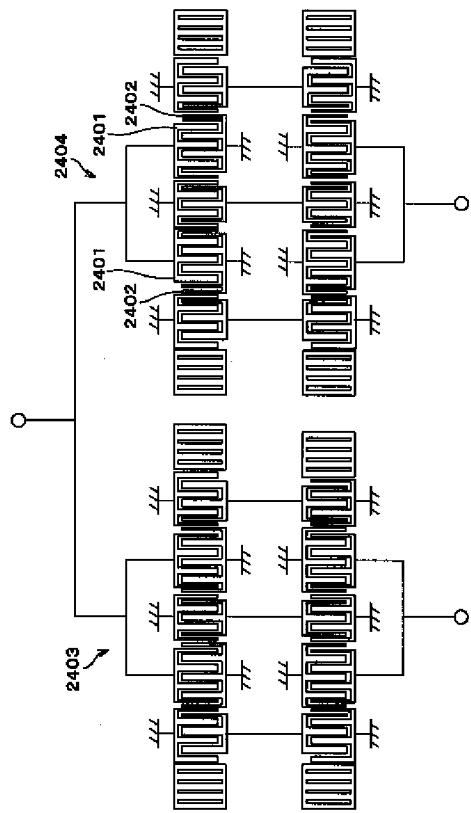
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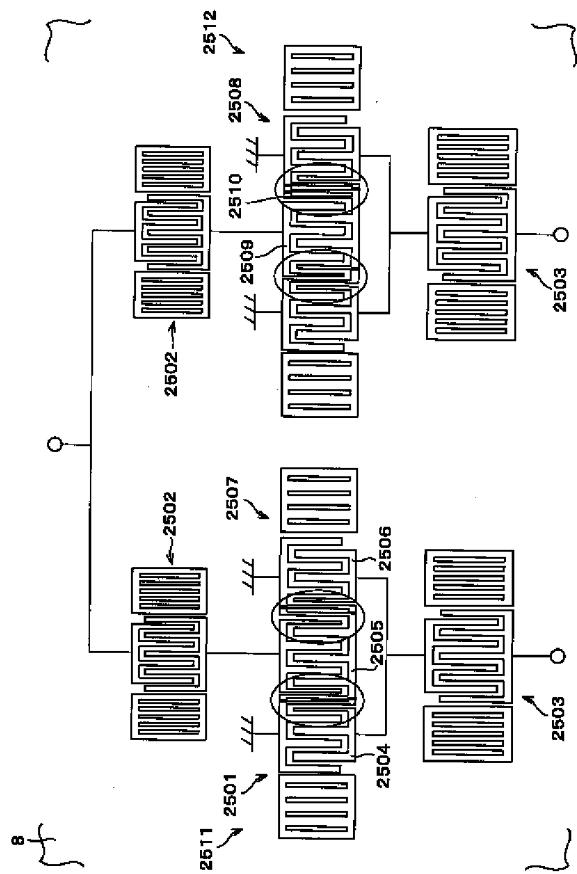
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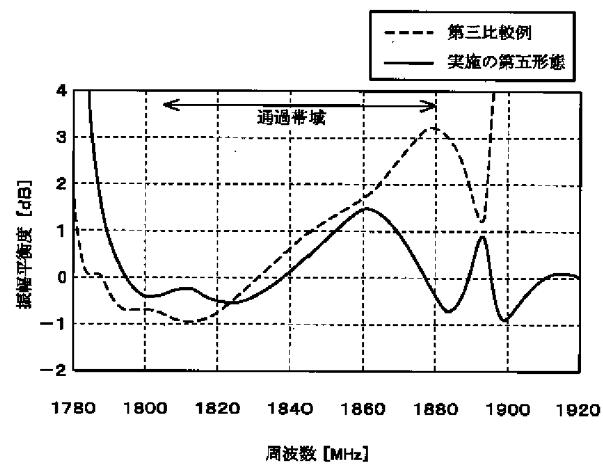
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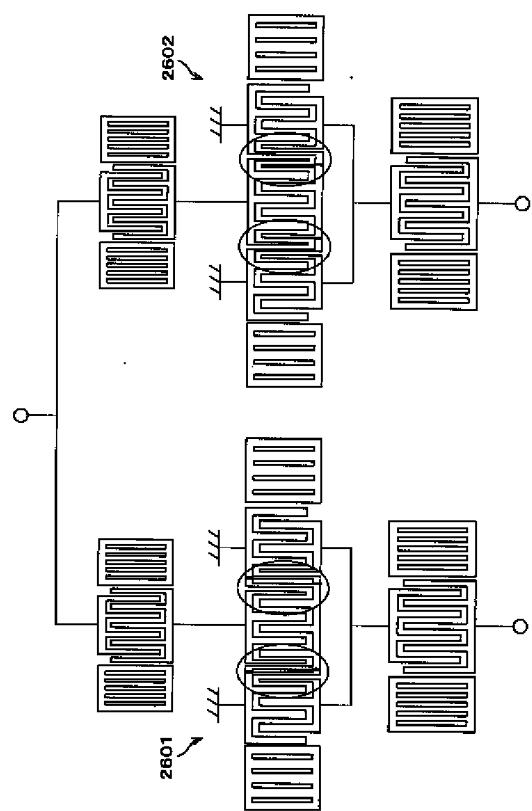
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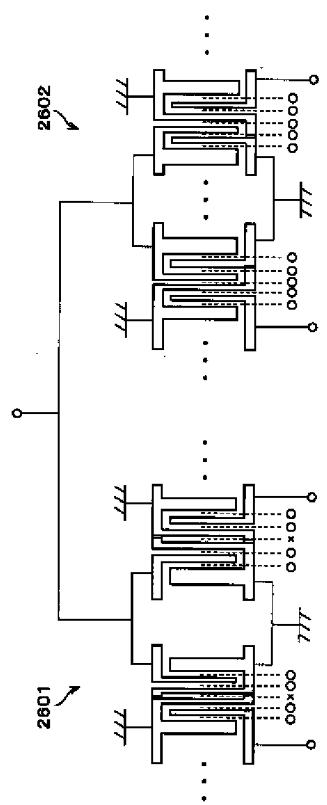
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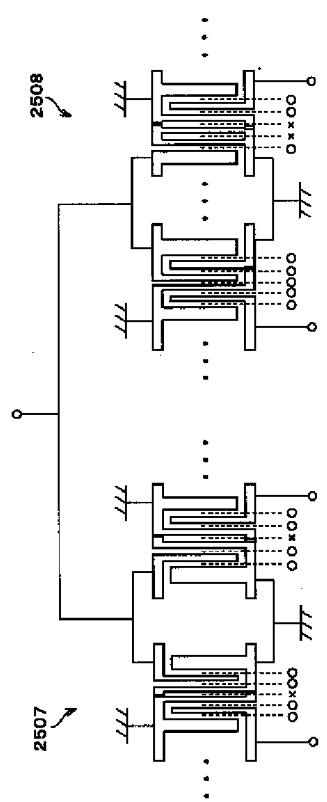
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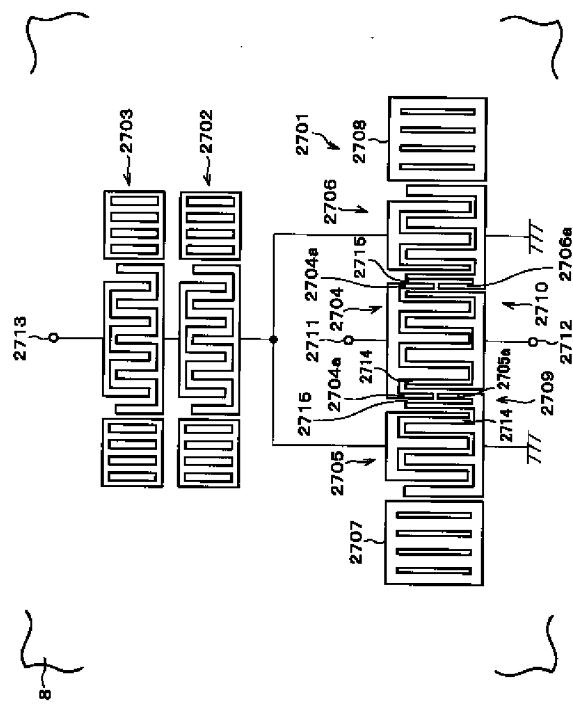
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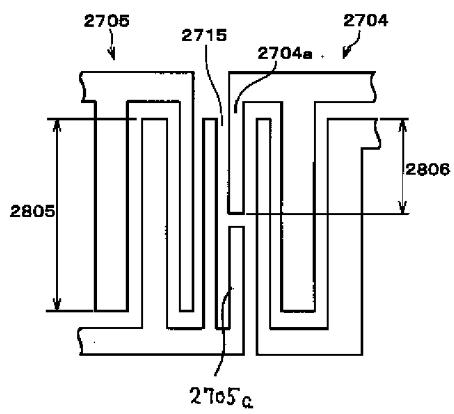
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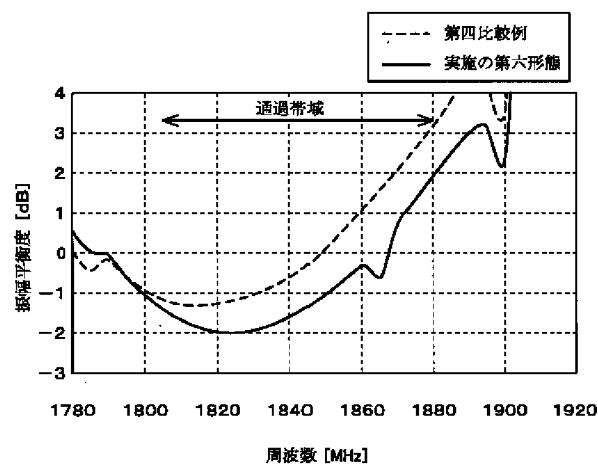
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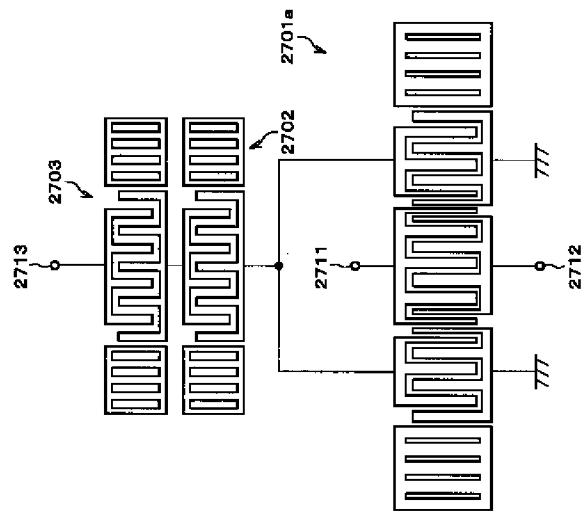
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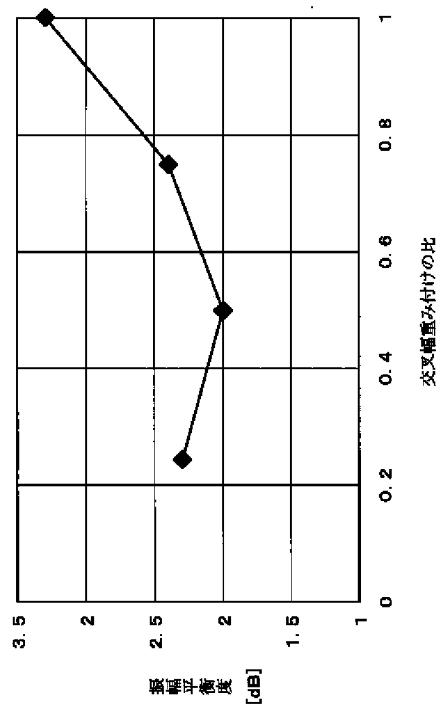
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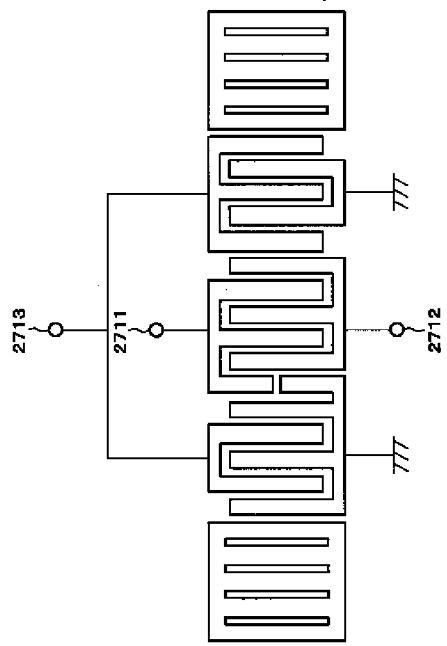
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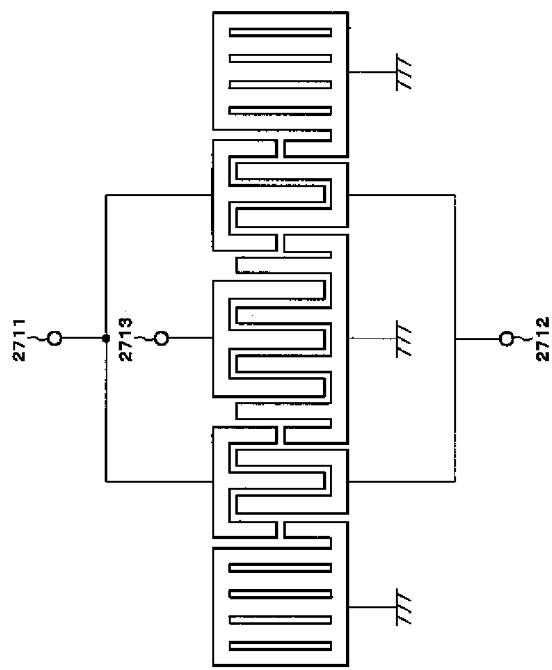
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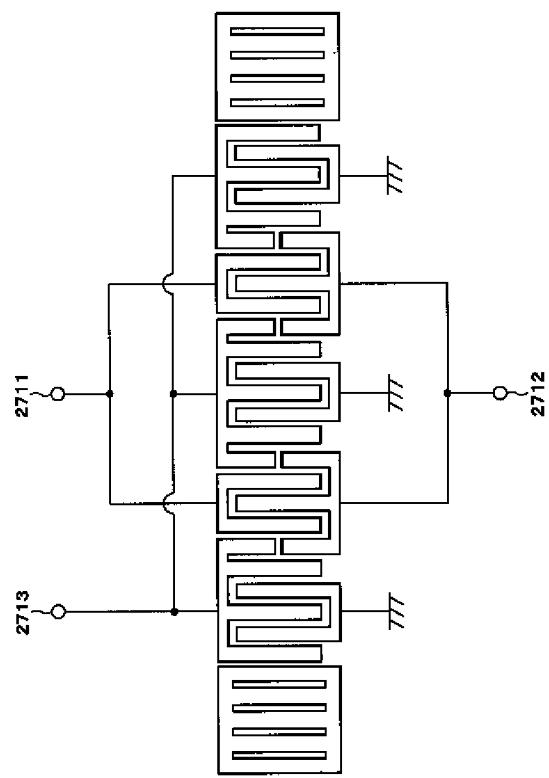
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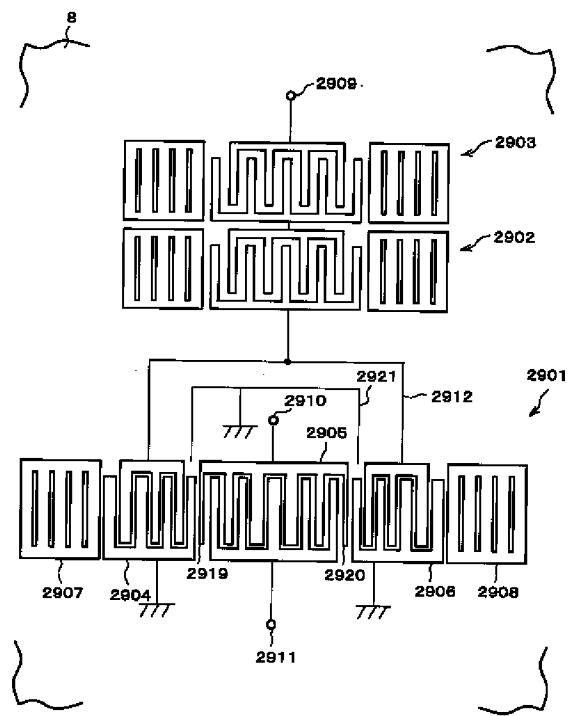
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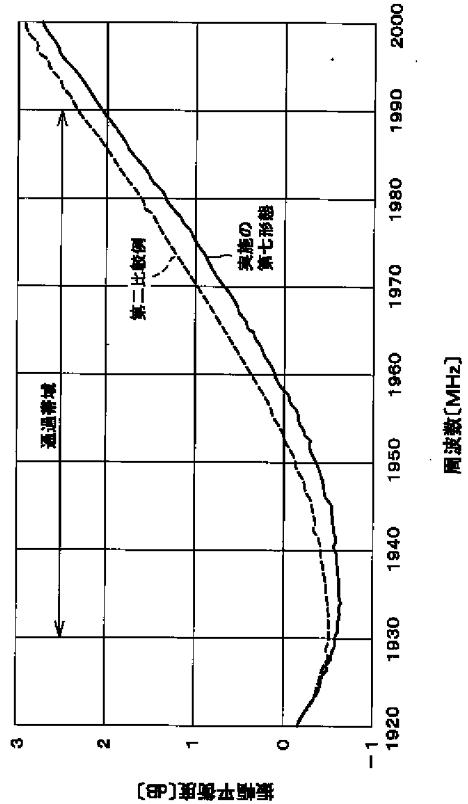
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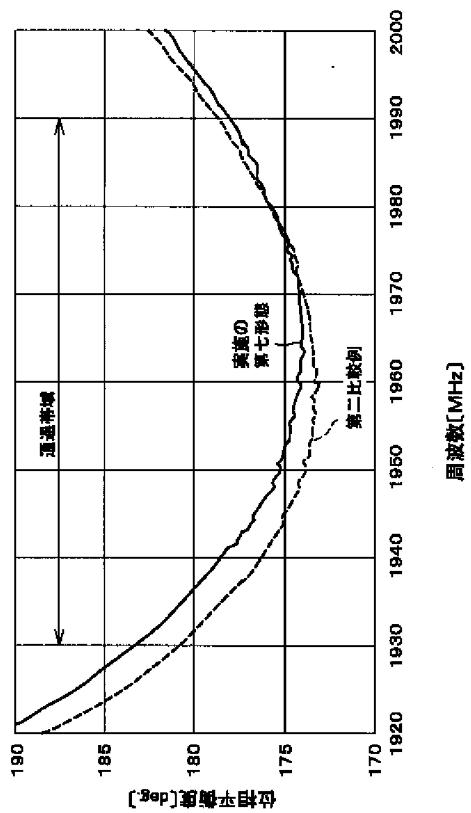
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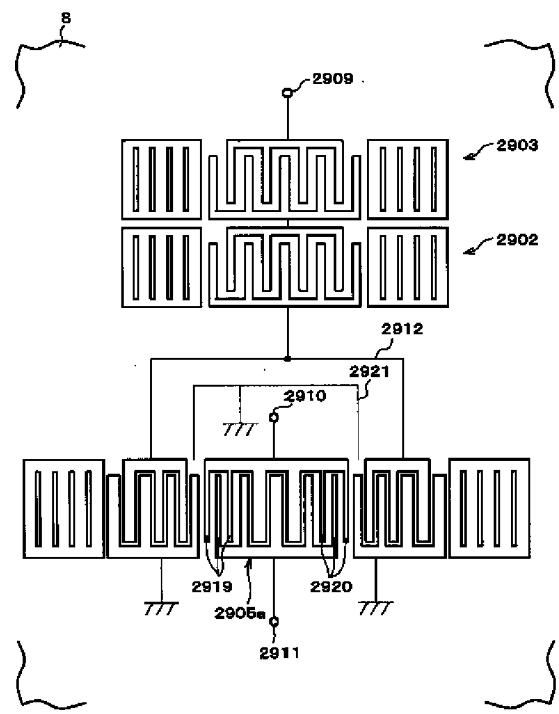
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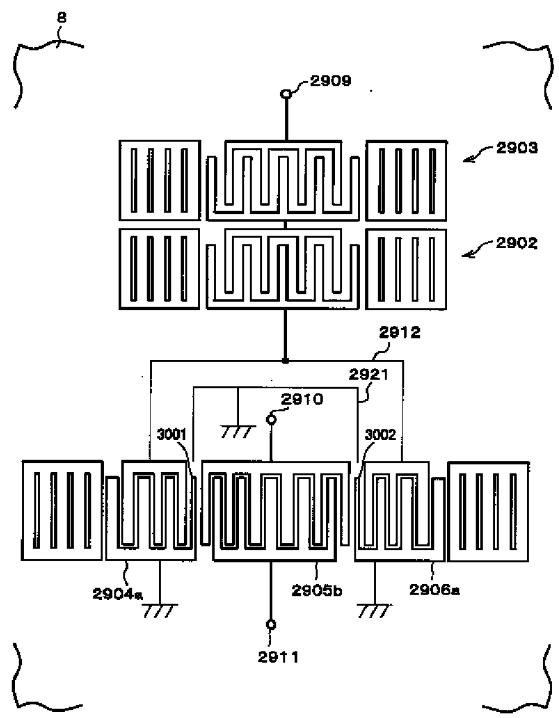
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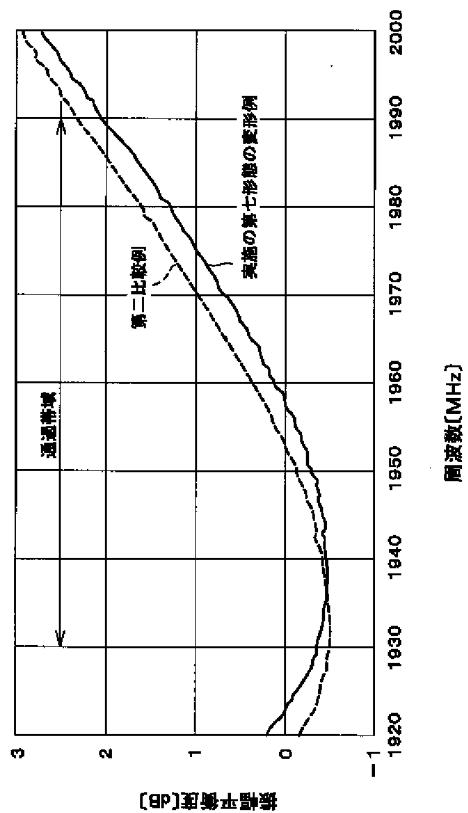
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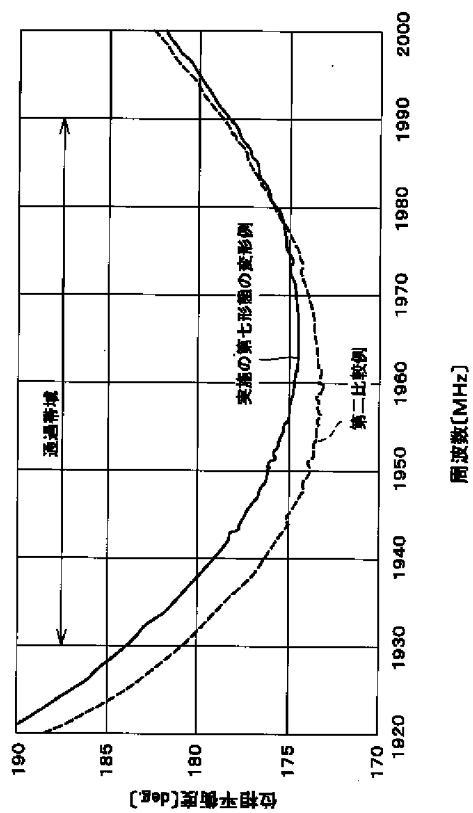
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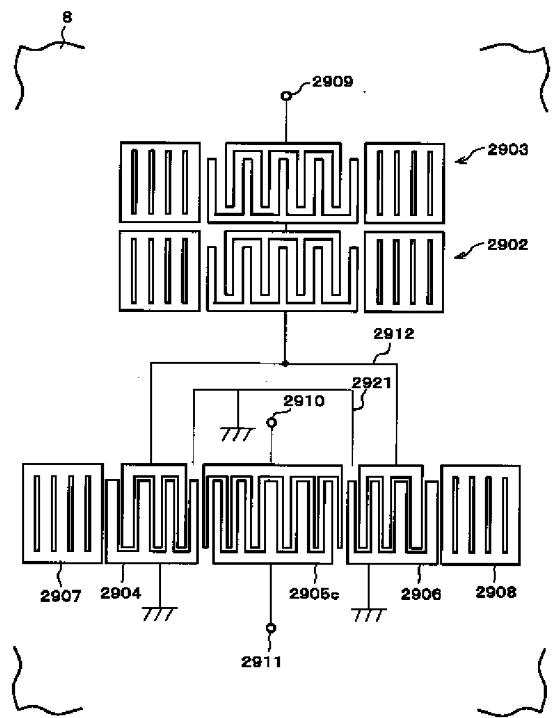
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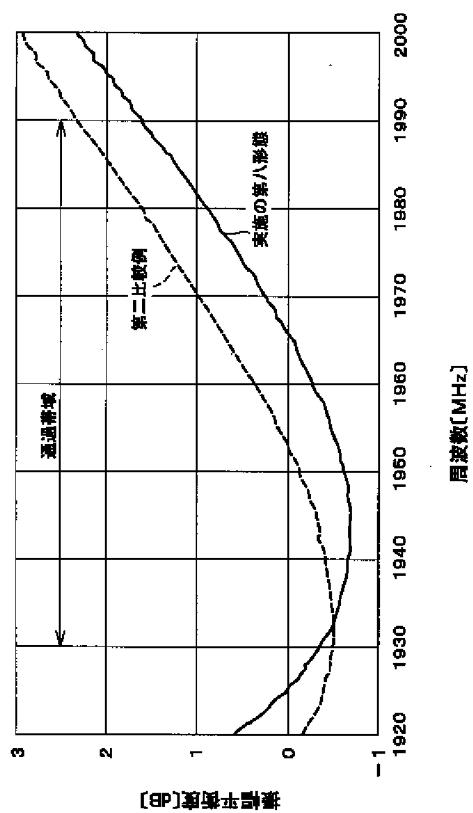
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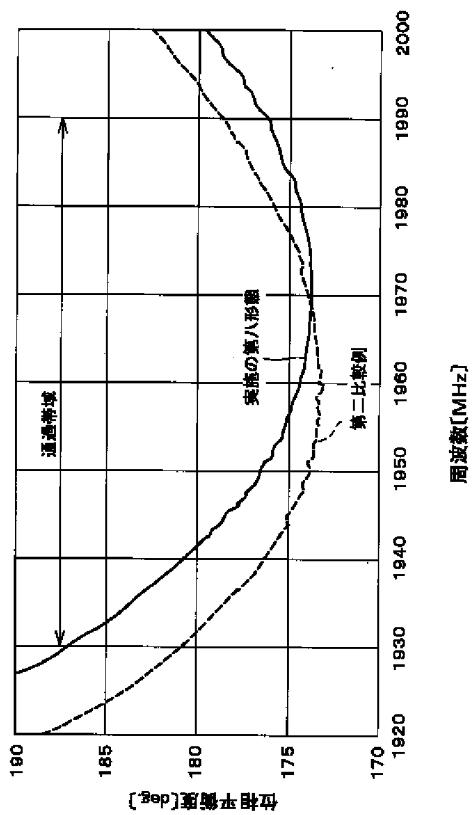
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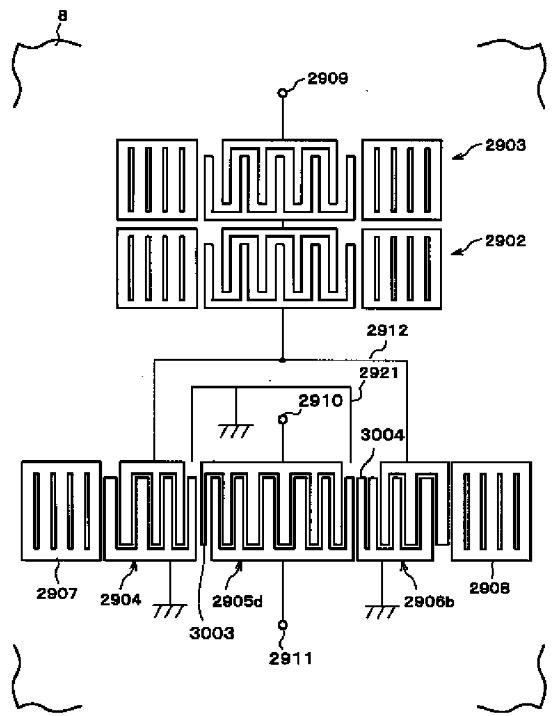
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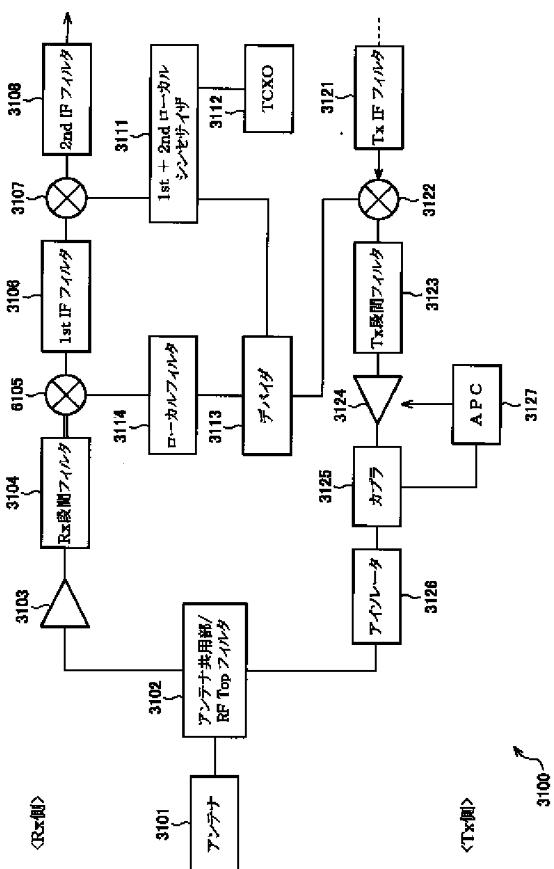
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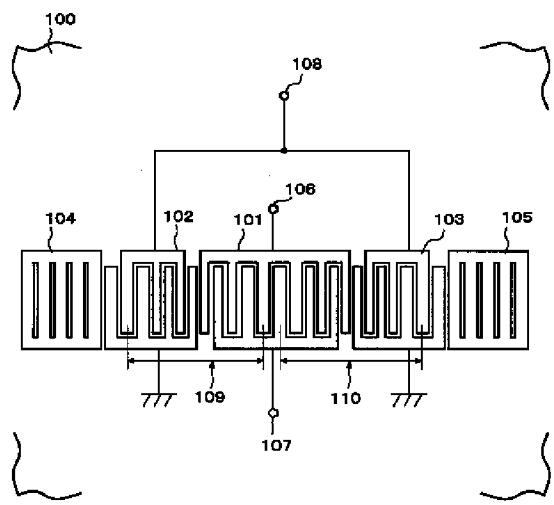
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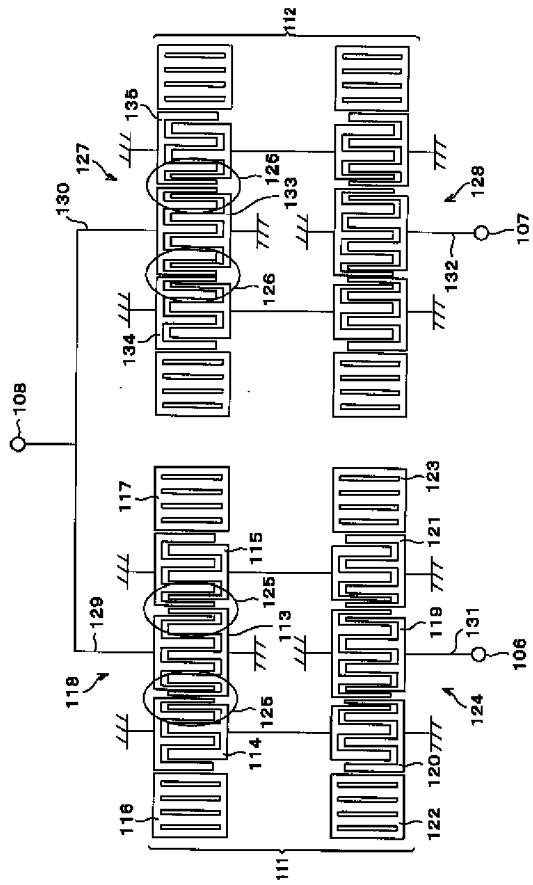
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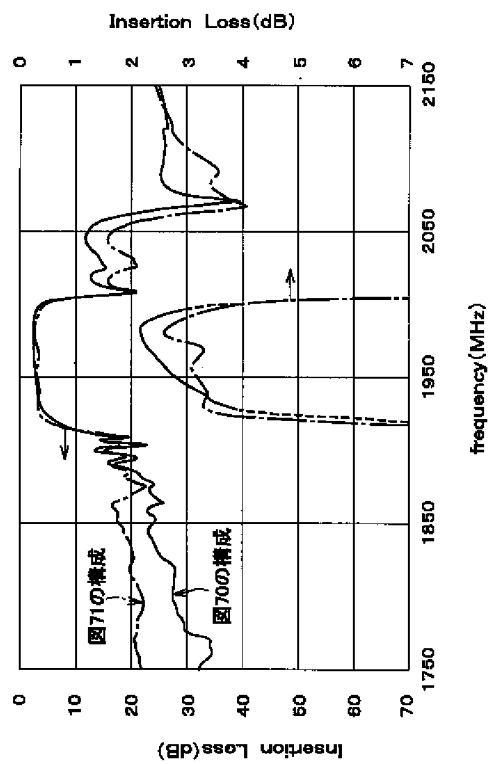
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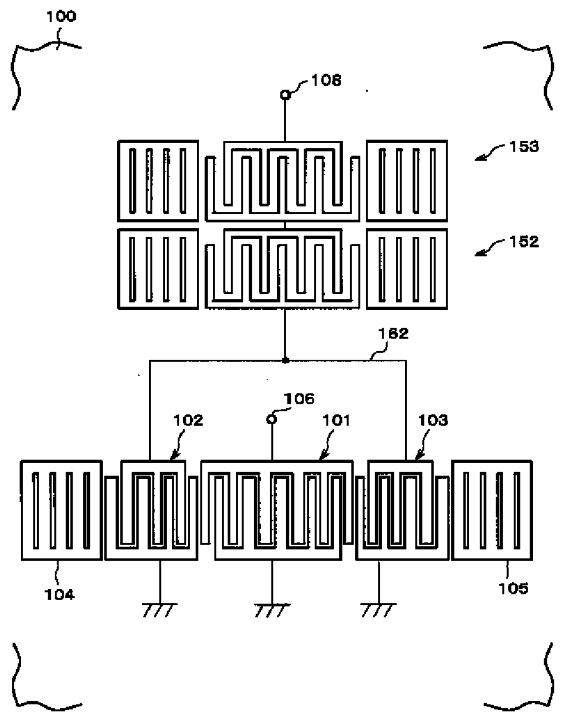
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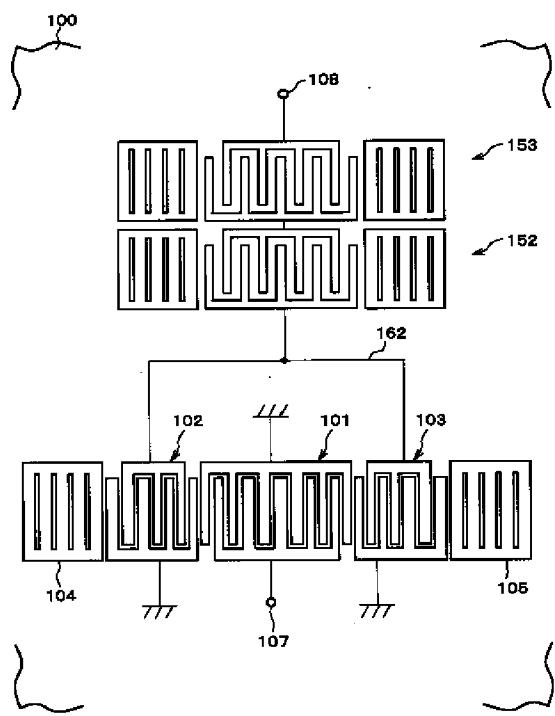
[Drawing 69]



[Drawing 70]

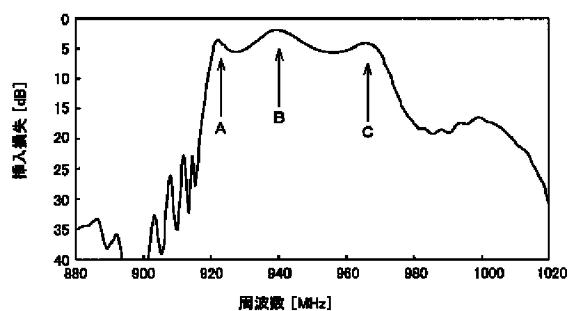


[Drawing 71]

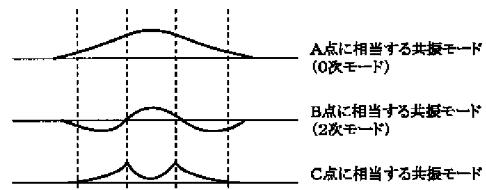
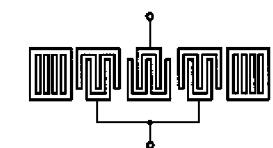


[Drawing 72]

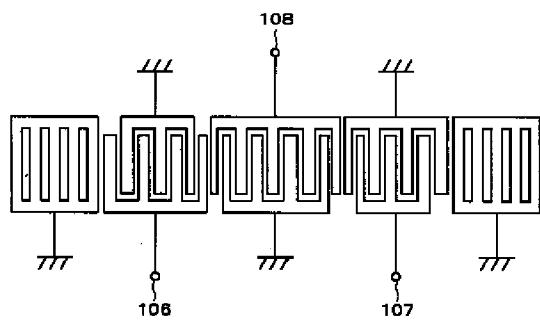
(a)



(b)



[Drawing 73]



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[Translation done.]

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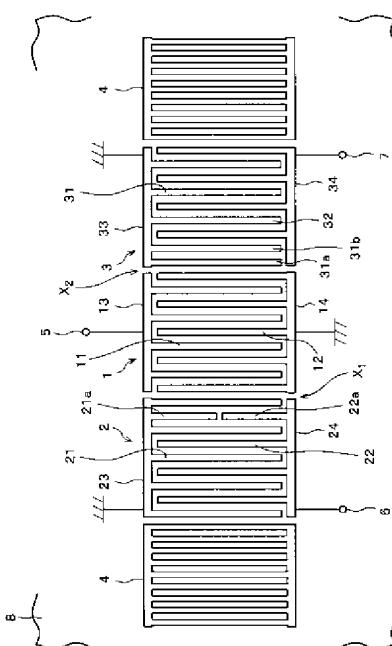
(54) 【発明の名称】 弹性表面波装置、通信装置

## (57) 【要約】

【課題】 バランス性が改善された平衡型-不平衡型変換機能を有する弹性表面波装置及びそれを用いた通信装置を提供する。

【解決手段】 圧電基板8上に、複数の電極指を有するくし型電極部1、2、3を、複数、縦結合共振子型を形成するように弹性表面波の伝搬方向に沿って設ける。くし型電極部1、2、3の一部は、平衡用であり、平衡側の少なくとも一方の各電極指21、22の最外電極指と異なる内側電極指23に、重み付けされた重み付け電極指22aを設ける。

【選択図】 図1



## 【特許請求の範囲】

## 【請求項 1】

圧電基板上に、複数の電極指を有する入力用くし型電極部と、複数の電極指を有する出力用くし型電極部とが、縦結合共振子型を形成するように弹性表面波の伝搬方向に沿って設けられ、

前記入力用くし型電極部及び出力用くし型電極部の一方は、平衡用であり、平衡側の少なくとも一方の各電極指の最外電極指と異なる内側電極指に、重み付けされた重み付け電極指を有していることを特徴とする弹性表面波装置。

## 【請求項 2】

前記重み付け電極指は、一つのくし型電極部における最外電極指の次から全電極指の1／2以内までの範囲内に設けられていることを特徴とする請求項1に記載の弹性表面波装置。

## 【請求項 3】

前記入力用くし型電極部及び出力用くし型電極部の少なくとも一方の各電極指に、別のくし型電極部と互いに対面する位置の最外電極指を含む2本以上、連続したアース電極指が形成されていることを特徴とする請求項1又は2に記載の弹性表面波装置。

## 【請求項 4】

前記重み付け電極指は、前記入力用くし型電極部及び出力用くし型電極部の少なくとも一方の接地された電極指である各アース電極指の隣り合う間にて形成される無電界部を、平衡用の2つのくし型電極部が共に有するように設定されていることを特徴とする請求項1乃至8の何れか1項に記載の弹性表面波装置。

## 【請求項 5】

前記重み付け電極指は、平衡用の2つのくし型電極部に、それぞれ、2本以上互いに連続したアース電極指からなる無電界部を有するように設定されていることを特徴とする請求項1乃至8の何れか1項に記載の弹性表面波装置。

## 【請求項 6】

平衡用の2つのくし型電極部で、前記無電界部の大きさが、ほぼ同一となるように設定されていることを特徴とする請求項4又は5に記載の弹性表面波装置。

## 【請求項 7】

前記重み付け電極指は、他の電極指より短く設定されていることを特徴とする請求項1乃至6の何れか1項に記載の弹性表面波装置。

## 【請求項 8】

前記重み付け電極指に向かって、接地された第一バランス用電極指が上記重み付け電極指の長さに合わせて延びるように形成されていることを特徴とする請求項1乃至7の何れか1項に記載の弹性表面波装置。

## 【請求項 9】

前記重み付け電極指と異なる位置に向かって、接地された第二バランス用電極指が上記重み付け電極指の長さに合わせて形成され、

上記第二バランス用電極指と、重み付け電極指とに対面するように折れ曲がって形成されるダミー電極が設けられていることを特徴とする請求項1乃至8の何れか1項に記載の弹性表面波装置。

## 【請求項 10】

不平衡型－平衡型変換機能を有していることを特徴とする請求項1乃至9の何れか1項に記載の弹性表面波装置。

## 【請求項 11】

圧電基板上に弹性表面波の伝搬方向に沿って形成された少なくとも2つのくし型電極部を有する弹性表面波フィルタを少なくとも1つと、上記弹性表面波フィルタのための入力信号端子及び出力信号端子とを備えている弹性表面波装置であって、

入力信号端子及び出力信号端子の少なくとも一方は平衡信号端子に接続されており、かつ、上記くし型電極部における、最外電極指以外の電極指が、電極指の交叉幅を他の電極指

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と異なる交叉幅重み付けされていることを特徴とする弾性表面波装置。

【請求項 12】

前記交叉幅重み付けは、電極指が他の電極指より短く設定されて施されていることを特徴とする請求項11に記載の弾性表面波装置。

【請求項 13】

前記交叉幅重み付けは、交叉方向の略中央部にて施されていることを特徴とする請求項11又は12に記載の弾性表面波装置。

【請求項 14】

前記くし型電極部には上記交叉幅重み付けされた電極指に対向するようにダミー電極が設けられていることを特徴とする請求項11乃至18の何れか1項に記載の弾性表面波装置。

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【請求項 15】

前記ダミー電極は、アースに接続されていることを特徴とする請求項14記載の弾性表面波装置。

【請求項 16】

前記重み付けが、前記弾性表面波フィルタの互いに隣り合うくし型電極部のうち少なくとも一方における、上記くし型電極部が互いに隣り合う箇所の最外電極指から数本の電極指に対して施されていることを特徴とする請求項1乃至15の何れか1項に記載の弾性表面波装置。

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【請求項 17】

前記重み付けが、前記弾性表面波フィルタの互いに隣り合うくし型電極部のうち少なくとも一方における、上記くし型電極部が互いに隣り合う箇所の最外電極指の近傍に位置する数本の電極指に対して施されていることを特徴とする請求項1乃至15の何れか1項に記載の弾性表面波装置。

【請求項 18】

前記重み付けが、前記弾性表面波フィルタの互いに隣り合うくし型電極部のうち少なくとも一方における、上記くし型電極部が互いに隣り合う箇所の最外電極指から上記くし型電極部の弾性表面波の伝搬方向の1/2以内までの範囲の電極指に対して施されていることを特徴とする請求項1乃至15の何れか1項に記載の弾性表面波装置。

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【請求項 19】

前記弾性表面波フィルタの互いに隣り合うくし型電極部の互いに隣り合う箇所の電極指がそれぞれアース電極指とシグナル電極指とであり、  
上記アース電極指及びシグナル電極指の少なくとも一方に対して前記重み付けが施されていることを特徴とする請求項1乃至18の何れか1項に記載の弾性表面波装置。

【請求項 20】

前記重み付けされる電極指は、前記弾性表面波フィルタのシグナル電極指であることを特徴とする請求項1乃至19の何れか1項に記載の弾性表面波装置。

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【請求項 21】

前記重み付けは、前記弾性表面波フィルタの平衡信号端子に接続されているくし型電極部の電極指に施されていることを特徴とする請求項1乃至20の何れか1項に記載の弾性表面波装置。

【請求項 22】

前記弾性表面波フィルタは、少なくとも1つのくし型電極部を他のくし型電極部に対して位相反転して有し、

前記重み付けは、上記位相反転したくし型電極部の電極指に対して施されていることを特徴とする請求項1乃至21の何れか1項に記載の弾性表面波装置。

【請求項 23】

圧電基板上に弾性表面波の伝搬方向に沿って形成された、それぞれ互いに隣り合う少なくとも8つのくし型電極部を有する弾性表面波フィルタを少なくとも1つと、上記弾性表面波フィルタのための入力信号端子及び出力信号端子とを備えている弾性表面波装置であつ

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て、

入力信号端子及び出力信号端子の少なくとも一方は平衡信号端子に接続されており、互いに隣り合うくし型電極部の少なくとも一方において、上記くし型電極部が互いに隣り合う箇所の最外電極指のひし七角形を他の電極指と異ならせるひし七角形重み付けが施されており、

かつ、異なる互いに隣り合うくし型電極部の少なくとも一方において、上記くし型電極部が互いに隣り合う箇所の最外電極指に対して間引き重み付けされていると共に、上記間引き重み付けされた箇所には、上記間引き重み付けされた電極指が接続されたバスバーと対向する対向バスバーに接続されたダミー電極が設けられていることを特徴とする弹性表面波装置。

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【請求項 24】

前記弹性表面波フィルタは、平衡信号入力ー平衡信号出力フィルタ機能を有するように設けられていることを特徴とする請求項 1 乃至 23 の何れか 1 項に記載の弹性表面波装置。

【請求項 25】

前記弹性表面波フィルタは、平衡信号入力ー不平衡信号出力フィルタ機能、又は不平衡信号入力ー平衡信号出力フィルタ機能を有するように設けられていることを特徴とする請求項 1 乃至 23 の何れか 1 項に記載の弹性表面波装置。

【請求項 26】

前記くし型電極部の少なくとも 1 つは、交叉幅方向に 2 分割されていることを特徴とする請求項 24 又は 25 に記載の弹性表面波装置。

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【請求項 27】

前記の対となる平衡信号端子が、1 つのくし型電極部における両極のくし歯状電極にそれぞれ接続されていることを特徴とする請求項 24 乃至 26 の何れか 1 項に記載の弹性表面波装置。

【請求項 28】

前記くし型電極部の少なくとも 1 つは、弹性表面波の伝搬方向に 2 分割されていることを特徴とする請求項 24 又は 25 に記載の弹性表面波装置。

【請求項 29】

前記の対となる平衡信号端子間に、接地された電気的中性点を有さないことを特徴とする請求項 24 乃至 29 の何れか 1 項に記載の弹性表面波装置。

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【請求項 30】

前記弹性表面波フィルタが、2 つにて、平衡信号入力ー平衡信号出力フィルタ機能を有するように設けられていることを特徴とする請求項 1 乃至 23 の何れか 1 項に記載の弹性表面波装置。

【請求項 31】

前記弹性表面波フィルタが、2 つ、入力信号に対する出力信号の位相を約 180 度異なるように設けられ、

上記各記弹性表面波フィルタは、平衡信号入力ー不平衡信号出力フィルタ機能、又は不平衡信号入力ー平衡信号出力フィルタ機能を有するように設けられていることを特徴とする請求項 1 乃至 23 の何れか 1 項に記載の弹性表面波装置。

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【請求項 32】

不平衡信号端子側に、さらに弹性表面波フィルタがカスケード接続されていることを特徴とする請求項 31 に記載の弹性表面波装置。

【請求項 33】

前記弹性表面波フィルタは、縦結合共振子型弹性表面波フィルタであることを特徴とする請求項 1 乃至 32 の何れか 1 項に記載の弹性表面波装置。

【請求項 34】

前記縦結合共振子型弹性表面波フィルタは、奇数個のくし型電極部を有していることを特徴とする請求項 33 に記載の弹性表面波装置。

【請求項 35】

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前記縦結合共振子型弹性表面波フィルタは、3つのくし型電極部を有していることを特徴とする請求項34に記載の弹性表面波装置。

【請求項36】

前記縦結合共振子型弹性表面波フィルタは、少なくとも1つのくし型電極部の総電極指本数が偶数本であることを特徴とする請求項33乃至35の何れか1項に記載の弹性表面波装置。

【請求項37】

縦結合共振子型弹性表面波フィルタは、3つ以上のくし型電極部のうち、少なくとも平衡信号端子に接続されている、くし型電極部の電極指の総本数が偶数本であることを特徴とする請求項36に記載の弹性表面波装置。

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【請求項38】

縦結合共振子型弹性表面波フィルタは、3つ以上のくし型電極部のうち、少なくとも中央部に位置する、くし型電極部の電極指の総本数が偶数本であることを特徴とする請求項36又は37に記載の弹性表面波装置。

【請求項39】

前記弹性表面波フィルタに、直列及び並列の少なくとも一方にて、弹性表面波共振子が少なくとも1つ接続されていることを特徴とする請求項1乃至38の何れか1項に記載の弹性表面波装置。

【請求項40】

前記弹性表面波フィルタは、2つ以上の弹性フィルタ部をカスケード接続したものであることを特徴とする請求項1乃至39の何れか1項に記載の弹性表面波装置。

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【請求項41】

請求項1乃至40の何れか1項に記載の弹性表面波装置を用いたことを特徴とする通信装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】

本発明は、不平衡型-平衡型変換機能を有するフィルタ等に用いられる弹性表面波装置及びそれを用いた通信装置に関するものである。

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【0002】

【従来の技術】

近年、携帯電話機等の通信装置の小型化、軽量化に対する技術的進歩は目覚しいものがある。このような通信装置に用いられるフィルタとしては、使用周波数帯域が高くなるに従い、小型化が可能な弹性表面波装置が用いられるようになっている。さらに、通信装置における、各構成部品数の削減、小型化のために、複数の機能を複合した部品の開発も進んできた。

【0003】

このような状況を背景に、携帯電話機のRF段に使用する弹性表面波フィルタに平衡-不平衡変換機能、いわゆるバラン(balun)の機能を備えたものも近年盛んに研究され、GSM(Global System for Mobile communications)などを中心に使用されるようになってきた。このような平衡-不平衡変換機能を備えた弹性表面波フィルタに関する特許も、いくつか出願されている。

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【0004】

入力インピーダンスと出力インピーダンスがほぼ等しい、平衡-不平衡変換機能を有する弹性表面波フィルタとしては、図67に示すような構成が知られている。

【0005】

図67に記載の弹性表面波装置は、圧電基板100上に、くし型電極部(すだれ状電極部ともいう、Inter-Digital Transducer、以下、IDTという)101が設けられ、上記IDT101の左右(弹性表面波の伝搬方向に沿って)にIDT102、IDT103がそれぞれ配置されている、平衡-不平衡変換機能を有するSID

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Tタイプの縦結合共振子型の弹性表面波装置である。

【0006】

上記弹性表面波装置には、さらに、上記各IDT102、101、103を左右から挟み込むように、反射器(リフレクタ)104、反射器105がそれぞれ配置されており、平衡信号端子として各端子106、107と、不平衡信号端子として端子108とが設けられている。

【0007】

また、入カインピーダンスと出カインピーダンスとを互いに、例えば4倍異ならせ、平衡-不平衡変換機能を有する、他の弹性表面波装置としては、例えば特開平10-117128号公報に記載の構成が挙げられる。

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【0008】

上記公報に記載の弹性表面波装置は、図68に示すように、圧電基板上に、第1の弹性表面波フィルタ111と、第1の弹性表面波フィルタ111とは出力信号の位相が180度異なる第2の弹性表面波フィルタ112とを有している。なお、図68において、圧電基板の記載は省略されている。これにより、上記弹性表面波装置は、フィルタ機能と共に、平衡-不平衡変換機能を発揮できる。

【0009】

第1の弹性表面波フィルタ111は、3IDTタイプの縦結合共振子型弹性表面波フィルタ118と、縦結合共振子型弹性表面波フィルタ118に対して、弹性表面波の伝搬方向に沿った対称線を挟んで鏡面対称となる3IDTタイプの縦結合共振子型弹性表面波フィルタ124とを、カスケード接続、つまり2段縦続接続したものである。

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【0010】

縦結合共振子型弹性表面波フィルタ118は、中央のIDT113の左右(弹性表面波の伝搬方向に沿って)に各IDT114、115をそれぞれ配置し、これら>IDT114、113、105をさらに左右の両側から挟み込むように、反射器116、117がそれぞれ配置されたものである。縦結合共振子型弹性表面波フィルタ124は、同様に、中央のIDT119の左右に各IDT120、121をそれぞれ配置し、これら>IDT120、119、121を挟み込むように、反射器122、123が配置されたものである。

【0011】

第2の弹性表面波フィルタ112は、3IDTタイプの縦結合共振子型弹性表面波フィルタ124と同じ縦結合共振子型弹性表面波フィルタ128と、3IDTタイプの縦結合共振子型弹性表面波フィルタ118に対して、中央のIDT108の向きを反転させて位相を反転させた(つまり約180°)IDT133を備えている縦結合共振子型弹性表面波フィルタ127とを2段縦続接続したものである。

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【0012】

第1、第2の弹性表面波フィルタ111、112のそれぞれ一方の各端子129、130を電気的に並列に接続し、もう一方の各端子181、182を電気的に直列に接続し、並列に接続した端子で不平衡端子108、直列に接続した端子で各平衡端子106、107を構成している。

【0013】

平衡-不平衡変換機能を有する弹性表面波装置において、不平衡端子108と各平衡端子106、107のそれぞれの端子との間の通過帯域内での伝送特性には、振幅特性が相等しく、かつ位相特性が互いに180度反転していることが要求されている。これらの特性は、振幅平衡度及び位相平衡度とそれぞれ呼ばれている。

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【0014】

振幅平衡度及び位相平衡度とは、前記平衡-不平衡変換機能を有する弹性表面波装置を3ポートのデバイスと考え、例えば不平衡入力端子をポート1、各平衡出力端子のそれぞれをポート2、ポート3としたとき、

$$\text{振幅平衡度} = |A|, A = |20| - |20| \quad (S21) - |20| \quad (S31)$$

| 式 (1)

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$$\text{位相平衡度} = |B|, B = |\angle S_{21} - \angle S_{31}| \quad \text{式 (2)}$$

で定義する。なお、 $S_{21}$ はポート1からポート2への伝達係数を、 $S_{31}$ はポート1からポート3への伝達係数を示している。このような平衡度は、理想的には、弹性表面波装置のフィルタ特性における、通過帯域内で振幅平衡度が0dB、位相平衡度は180度とされている。

【0015】

【発明が解決しようとする課題】

しかしながら、上記のような、平衡信号端子を有する弹性表面波装置においては、平衡信号端子間の平衡度が悪化しているという問題があつた。平衡度が悪い原因はいくつか挙げられるが、その1つとして、平衡信号端子106に接続されている電極指とIDT102のシグナル電極指との距離(図67の109)と、平衡信号端子107に接続されている電極指とIDT108のシグナル電極指との距離(図67の110)が、電極指のピッチで決まる波長の0.5倍異なることが挙げられる。

【0016】

これにより、各平衡信号端子106、107のそれぞれに接続されている電極指の総容量が異なる、電気信号と弹性表面波との間での変換効率が異なるといった弊害が発生し、結果、平衡度の悪化につながっていた。

【0017】

そこで、図70のように、図67の平衡信号端子107をアースに接続して平衡信号端子106から出力される周波数に対する振幅特性と、図71のように、図67の平衡信号端子106をアースに接続して平衡信号端子107から出力される振幅特性とを測定し、これらの結果としての上記振幅特性の差を図69に示す。2つの振幅特性は互いに大きく異なるっており、この差が平衡度の悪化につながっている。

【0018】

また、図68に示した、カスケード接続した弹性表面波装置では、2つの互いに隣り合う各IDTにおける、互いに対面する2箇所の各電極指の極性が左右非対称な状態であることに起因して、平衡度が悪化するという問題を生じている。

【0019】

つまり、IDT118が、隣り合う各IDT114、115と各箇所(図68の125)では、互いに隣り合う各IDT118、114、115の最外電極指がどちらもアース電極指であるのに対し、IDT138が、隣り合う各IDT134、135と隣り合う各箇所(図68の126)においては、シグナル電極指とアース電極となっている。このように隣り合う各IDTの最外電極指における極性の組み合わせが変わると、電気信号と弹性表面波との間での変換により、図72に示す共振モードの周波数や振幅レベルが変化する。

【0020】

図68のよう、上記のような、互いに隣り合う各IDTにおける各最外電極指の組み合わせが相異なる2つの縦結合共振子型弹性表面波フィルタを組み合わせて、平衡-不平衡変換機能を備えた弹性表面波装置を構成した場合、この共振モードのずれが平衡信号端子間の平衡度悪化の原因となっていた。

【0021】

この現象は、図73に示すような、1つの縦結合共振子型弹性表面波フィルタを用いて、平衡-不平衡変換機能を備えた弹性表面波装置を構成した場合においても、上記の共振モードのずれが同様に発生し、平衡信号端子間の平衡度悪化の原因となっていた。

【0022】

本発明の目的は、平衡信号端子間の平衡度悪化の一因である上記の平衡信号端子間の差を是正することで、平衡信号端子間の平衡度が良好な、平衡-不平衡変換機能を有する弹性表面波装置、及びそれを用いた通信装置を提供することにある。

【0023】

【課題を解決するための手段】

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本発明の弾性表面波装置は、以上の課題を解決するために、圧電基板上に、複数の電極指を有する入力用 I D T と、複数の電極指を有する出力用 I D T とが、縦結合共振子型を形成するように弾性表面波の伝搬方向に沿って設けられ、前記入力用 I D T 及び出力用 I D T の一方は、平衡用であり、平衡側の少なくとも一方の各電極指の最外電極指と異なる内側電極指に、重み付けされた重み付け電極指を有していることを特徴としている。上記弾性表面波装置においては、不平衡型－平衡型変換機能を有していてもよい。

【0024】

上記構成によれば、入力用 I D T 及び出力用 I D T の少なくとも一方の各電極指に、重み付け電極指を設けたことにより、出力信号、特に平衡用の各出力信号間の各特性（振幅バランス、位相バランス、伝送特性）のバランスを調整できるので、各特性のバランス性を改善できる。

【0025】

上記弾性表面波装置では、前記重み付け電極指は、一つの I D T における最外電極指の次から全電極指の 1/2 以内までの範囲内に設けられていることが好ましい。上記弾性表面波装置においては、前記重み付け電極指は、他の電極指より短く設定されていることが好ましい。

【0026】

上記弾性表面波装置では、前記入力用 I D T 及び出力用 I D T の少なくとも一方の各電極指に、別の I D T と互いに対面する位置の最外電極指を含む 2 本以上、連続したアース電極指が形成されていることが望ましい。

【0027】

上記構成によれば、一方の各電極指に、互いに対面する位置の最外電極指を含む 2 本以上、連続したアース電極指を形成することによって、例えば平衡用の各出力信号のように位相差を 180° に近く設定することを簡素な構成により確実化できる。

【0028】

上記弾性表面波装置においては、前記重み付け電極指は、前記入力用 I D T 及び出力用 I D T の少なくとも一方の接地された電極指である各アース電極指の隣り合う間に形成される無電界部を、平衡用の 2 つの I D T が共に有するように設定されていることが望ましい。

【0029】

上記弾性表面波装置では、前記重み付け電極指は、平衡用の 2 つの I D T に、それぞれ、2 本以上互いに連続したアース電極指からなる無電界部を有するように設定されてもよい。

【0030】

上記弾性表面波装置においては、平衡用の 2 つの I D T で、前記無電界部の大きさが、ほぼ同一となるように設定されていることが好ましい。

【0031】

上記構成によれば、重み付け電極指を、無電界部の大きさを制御、より好ましくは平衡用の 2 つの I D T で、前記無電界部の大きさを、ほぼ同一となるように設定することにより、各 I D T、特に出力用 I D T での弾性エネルギーから電気エネルギーへの変換のバランスを調整できるから、バランス性を向上できる。

【0032】

上記弾性表面波装置においては、前記重み付け電極指に向かって、接地された第一バランス用電極指が上記重み付け電極指の長さに合わせて延びるように形成されていることが望ましい。

【0033】

上記構成によれば、短く設定された重み付け電極指により形成される無電極指部分が、第一バランス用電極指によりある程度カバーできるので、上記無電極指部分によるバランス性の劣化を回避できる。

【0034】

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上記弹性表面波装置では、前記重み付け電極指と異なる位置に向かって、接地された第二バランス用電極指が上記重み付け電極指の長さに合わせて形成され、上記第二バランス用電極指と、重み付け電極指とに対面するように折れ曲がって形成されるダミー電極が設けられてもよい。

【0035】

上記構成によれば、ダミー電極を設けることによって、良好なバランス性を維持しながら、伝送特性をさらに向上できる。

【0036】

本発明の他の弹性表面波装置は、前記の課題を解決するために、圧電基板上に弹性表面波の伝搬方向に沿って形成された少なくとも2つのIDTを有する弹性表面波フィルタを少なくとも1つと、上記弹性表面波フィルタのための入力信号端子及び出力信号端子とを備えている弹性表面波装置であって、入力信号端子及び出力信号端子の少なくとも一方は平衡信号端子に接続されており、かつ、上記IDTにおける、最外電極指以外の電極指が、電極指の交叉幅を他の電極指と異ならせる交叉幅重み付けされていることを特徴とする。

【0037】

上記弹性表面波装置では、前記交叉幅重み付けは、電極指が他の電極指より短く設定されて施されていることが好ましい。前記交叉幅重み付けは、交叉方向の略中央部にて施されてもよい。前記IDTには上記交叉幅重み付けされた電極指に対向するようにダミー電極が設けられてもよい。上記ダミー電極は、アースに接続されてもよい。

【0038】

上記構成によれば、上記IDTにおける、最外電極指以外の電極指が、電極指の交叉幅を他の電極指と異ならせる交叉幅重み付けされているので、出力信号、特に平衡用の各出力信号間の各特性（振幅バランス、位相バランス、伝送特性）のバランスを調整できるので、各特性のバランス性を改善できる。

【0039】

上記弹性表面波装置においては、前記重み付けが、前記弹性表面波フィルタの互いに隣り合うIDTのうち少なくとも一方における、上記IDTが互いに隣り合う箇所の最外電極指から数本の電極指に対して施されてもよい。

【0040】

上記弹性表面波装置では、前記重み付けが、前記弹性表面波フィルタの互いに隣り合うIDTのうち少なくとも一方における、上記IDTが互いに隣り合う箇所の最外電極指の近傍に位置する数本の電極指に対して施されてもよい。

【0041】

上記弹性表面波装置においては、前記重み付けが、前記弹性表面波フィルタの互いに隣り合うIDTのうち少なくとも一方における、上記IDTが互いに隣り合う箇所の最外電極指から上記IDTの弹性表面波の伝搬方向の1/2以内までの範囲の電極指に対して施されてもよい。

【0042】

上記弹性表面波装置では、前記弹性表面波フィルタの互いに隣り合うIDTの互いに隣り合う箇所の電極指がそれぞれアース電極指とシグナル電極指であり、上記アース電極指及びシグナル電極指の少なくとも一方に対して前記重み付けが施されてもよい。

【0043】

上記弹性表面波装置においては、前記重み付けされる電極指は、前記弹性表面波フィルタのシグナル電極指であってもよい。

【0044】

上記弹性表面波装置では、前記重み付けは、前記弹性表面波フィルタの平衡信号端子に接続されているIDTの電極指に施されてもよい。

【0045】

上記弹性表面波装置においては、前記弹性表面波フィルタは、少なくとも1つのIDTを

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他の I D T に対して位相反転して有し、前記重み付けは、上記位相反転した I D T の電極指に対して施されてもよい。

【0046】

本発明のさらに他の弾性表面波装置は、前記の課題を解決するために、圧電基板上に弾性表面波の伝搬方向に沿って形成された、それぞれ互いに隣り合う少なくとも 8 つの I D T を有する弾性表面波フィルタを少なくとも 1 つと、上記弾性表面波フィルタのための入力信号端子及び出力信号端子とを備えている弾性表面波装置であって、入力信号端子及び出力信号端子の少なくとも一方は平衡信号端子に接続されており、互いに隣り合う I D T の少なくとも一方において、上記 I D T が互いに隣り合う箇所の最外電極指のひしょを他の電極指と異なるひしょ重み付けが施されており、かつ、異なる互いに隣り合う I D T の少なくとも一方において、上記 I D T が互いに隣り合う箇所の最外電極指に対して間引き重み付けされていると共に、上記間引き重み付けされた箇所には、上記間引き重み付けされた電極指が接続されたバスバーと対向する対向バスバーに接続されたダミー電極が設けられていることを特徴としている。

【0047】

上記弾性表面波装置では、前記弾性表面波フィルタは、平衡信号入力 - 平衡信号出力フィルタ機能を有するように設けられてもよい。

【0048】

上記弾性表面波装置においては、前記弾性表面波フィルタは、平衡信号入力 - 不平衡信号出力フィルタ機能、又は不平衡信号入力 - 平衡信号出力フィルタ機能を有するように設けられてもよい。

【0049】

上記弾性表面波装置においては、前記 I D T の少なくとも 1 つは、交叉幅方向に 2 分割されてもよい。

【0050】

上記弾性表面波装置では、前記の対となる平衡信号端子が、1 つの I D T における両極のくし歯状電極にそれぞれ接続されてもよい。

【0051】

上記弾性表面波装置においては、前記 I D T の少なくとも 1 つは、弾性表面波の伝搬方向に 2 分割されてもよい。

【0052】

上記弾性表面波装置では、前記の対となる平衡信号端子間に、接地された電気的中性点を有さないものであってもよい。

【0053】

上記弾性表面波装置においては、前記弾性表面波フィルタが、2 つにて、平衡信号入力 - 平衡信号出力フィルタ機能を有するように設けられてもよい。

【0054】

上記弾性表面波装置では、前記弾性表面波フィルタが、2 つ、入力信号に対する出力信号の位相を約 180 度異なるように設けられ、上記各記弾性表面波フィルタは、平衡信号入力 - 不平衡信号出力フィルタ機能、又は不平衡信号入力 - 平衡信号出力フィルタ機能を有するように設けられてもよい。

【0055】

上記弾性表面波装置においては、不平衡信号端子側に、さらに弾性表面波フィルタがカスクード接続されてもよい。

【0056】

上記弾性表面波装置では、前記弾性表面波フィルタは、縦結合共振子型弾性表面波フィルタであってもよい。

【0057】

上記弾性表面波装置においては、前記縦結合共振子型弾性表面波フィルタは、奇数個の I D T を有してもよい。

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## 【0058】

上記弹性表面波装置では、前記縦結合共振子型弹性表面波フィルタは、3つのIDTを有して置いてもよい。

## 【0059】

上記弹性表面波装置においては、前記縦結合共振子型弹性表面波フィルタは、少なくとも1つのIDTの総電極指本数が偶数本であってもよい。

## 【0060】

上記弹性表面波装置では、縦結合共振子型弹性表面波フィルタは、3つ又は3つ以上のIDTのうち、少なくとも平衡信号端子に接続されている、IDTの電極指の総本数が偶数本であってもよい。

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## 【0061】

上記弹性表面波装置においては、縦結合共振子型弹性表面波フィルタは、3つ又は3つ以上のIDTのうち、少なくとも中央部に位置する、IDTの電極指の総本数が偶数本であってもよい。

## 【0062】

上記弹性表面波装置では、前記弹性表面波フィルタに、直列及び並列の少なくとも一方にて、弹性表面波共振子が少なくとも1つ接続されてもよい。

## 【0063】

上記弹性表面波装置においては、前記弹性表面波フィルタは、2つ以上の弹性表面波フィルタ部をカスケード接続したものであってもよい。

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## 【0064】

本発明の通信装置は、前記の課題を解決するために、上記の何れかに記載の弹性表面波装置を用いたことを特徴としている。上記構成によれば、優れたバランス性を備えた弹性表面波装置を用いたので、通信性能を向上できる。

## 【0065】

## 【発明の実施の形態】

本発明の実施の各形態について図1乃至図65に基づいて説明すれば、以下の通りである。

## 【0066】

## (実施の第一形態)

本発明の実施の第一形態に係る弹性表面波装置は、図1に示すように、不平衡型-平衡型変換機能とフィルタ機能とを有するものであり、入力用のIDT1と、その両側(弹性表面波の伝搬方向に沿って)にそれぞれ配置された出力用の各IDT2、3と、さらにそれらの外側にそれぞれ配置された各反射器4とを、圧電基板8上に有している。なお、上記の入力と出力とは相互に入れ替え可能である。

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## 【0067】

つまり、出力用の各IDT2、3は、それらの間に入力用のIDT1を挟むように配置されている。さらに、各反射器4は、それらの間にIDT2、IDT1及びIDT3を挟むように配置されており、伝搬してくる弹性表面波を反射するようになっている。上記圧電基板8は、例えば $40 \pm 5^\circ$  Ycut X伝搬 LiTaO<sub>3</sub>からなるものである。

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## 【0068】

IDT1、2、3は、帯状の基端部(バスバー)と、その基端部の一方の側部から直交する方向に延びる複数の、互いに平行で等間隔な帯状の各電極指とを備えた電極指部を2つ備えており、上記各電極指部の電極指の側部を互いに対面するように互いの電極指間に入り組んだ状態にて上記各電極指部を有するものである。

## 【0069】

このようないD T 1、2、3では、各電極指の長さや幅、隣り合う各電極指の間隔、互いの電極指間での入り組んだ状態の対面長さを示す交叉幅を、それぞれ設定することにより信号変換特性や、通過帯域の設定が可能となっている。本実施の第一形態では、IDT1の電極指の本数は39本に設定され、IDT2、3の電極指の本数が23本に設定されて

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いる。

【0070】

また、上記の各電極指やバスバーや、各反射器4は、フォトリソグラフィー法等により圧電基板8上に形成された、例えばアルミニウム(AI)電極(箔)によって形成されている。

【0071】

そして、本実施の第一形態では、不平衡型信号を入力して、平衡型信号を出力するために、入力用のIDT1においては、不平衡用の入力端子5に接続された各シグナル電極指11と、接地された各アース電極指12が前述したように互いに入り組んだ状態にて設けられている。

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【0072】

また、上記IDT1では、弾性表面波の伝搬方向での両端部にある、最外電極指が、それぞれアース電極指となるようにアース電極指12は設定されている。上記最外電極指は、IDT2、3の各最外電極指の一方とそれぞれ対面する位置にある。

【0073】

一方、IDT2においては、各アース電極指21と、平衡用の出力端子6に接続されたシグナル電極指22とが前述したように互いに入り組んだ状態にて設けられている。また、各アース電極指21につながるバスバー23は、入力用のIDT1の各シグナル電極指11につながるバスバー13に対しほぼ直線状となるように配置されている。また、IDT2では、弾性表面波の伝搬方向での両端部の各電極指となる各最外電極指がそれぞれアース電極指21となっている。

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【0074】

IDT3では、各アース電極指31と、平衡用の出力端子7に接続されたシグナル電極指32とが前述した互いに入り組んだ状態にて設けられている。各アース電極指31につながるバスバー33は、入力用のIDT1の各シグナル電極指11につながるバスバー13に対しほぼ直線状となるように配置されている。

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【0075】

また、IDT1の各アース電極指12のバスバー14は、IDT2の各シグナル電極指22のバスバー24と、IDT3の各シグナル電極指32のバスバー34とをそれぞれ直線状となるように設定されている。

【0076】

さらに、本実施の第一形態では、出力用の各IDT2、3は、構造上において互いに反転して設けられている。つまり、IDT2においては、IDT1に近い方から、アース電極指より始まり、シグナル電極指、アース電極指と、交互に設定されている一方、IDT3では、IDT1に近い方から、シグナル電極指より始まり、アース電極指、シグナル電極指と、交互に設定されている。

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【0077】

これにより、本実施の第一形態においては、各IDT2、3間での振幅差が0、位相差が180°に近くなるように設定されているので、平衡-不平衡変換機能を発揮できることになる。

【0078】

そして、本実施の第一形態では、IDT1と、IDT3とが隣り合う箇所において、IDT3の最外電極指が間引き重み付けされている。間引き重み付けされた電極指の位置には、接地されたダミー電極31aが形成されている。これにより、IDT1と、IDT3との間の近傍となるIDT3では、アース電極指が、ダミー電極31a及びアース電極指31bというように2本連続で並ぶようになっている。

【0079】

さらに、本実施の第一形態では、出力用のIDT2におけるシグナル電極指22のうち入力用のIDT1に近い側(最外電極指)のアース電極指21の次となるシグナル電極指22の位置に交叉重み付け電極指22aを設定した。上記交叉重み付け電極指22aでは、

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交叉重み付け電極指 $22\alpha$ の長さが、他のシグナル電極指 $22$ の長さに対して、例えば約半分に、つまり交叉幅を調節した交叉重み付となるように設定されている。

【0080】

その上、短く設定された重み付け電極指 $22\alpha$ により生じた空間をうめるように、接地されているバスバー $23$ から延びる、オフセット電極指である帯状のダミー電極（第一バランス用電極指） $21\alpha$ が形成されている。ダミー電極 $21\alpha$ は、互いに隣り合う各アース電極指 $21$ に対し等間隔にてほぼ平行に、交叉重み付け電極指 $22\alpha$ の先端部に向かって延びている。

【0081】

次に、本実施の第一形態の作用・効果について説明する、まず、比較として、図2に、上記の間引き重み付け、及び交叉重み付けを行っていない、第一比較例の平衡-不平衡変換機能を有する弾性表面波装置の各IDTの概略構成図を示す。第一比較例の構成では、IDT1とIDT40との隣り合う箇所にはアース電極同士が並ぶのに対し、IDT1とIDT41との間には、シグナル電極とアース電極とが並んでいた。よって、IDT1とIDT40との間には、電気と弾性表面波の変換が行われない無電界部 $9$ が存在するのに対し、IDT1とIDT41との間では、電気信号（シグナル）と弾性表面波との間の変換が行われる。そのため平衡信号端子6、7から出力される信号の周波数や振幅レベルが異なり、さらに位相も完全に180度反転されず、結果、平衡信号端子間の平衡度が悪くなっていた。

【0082】

本実施の第一形態では、まず、第一比較例に示したシグナル電極とアース電極が並んでいたIDT1、IDT41が互いに隣り合う箇所の電極指を、図3に示すように、間引き重み付けし、さらに間引き重み付けされた電極指の位置に、ダミー電極 $31\alpha$ を形成した。つまり、IDT1とIDT8との間の近傍のIDT8には、2本のアース電極指が並ぶようにした。これにより、IDT1とIDT8との間、IDT1とIDT40との間の電気信号と弾性表面波との間での変換効率の差が是正され、平衡信号端子6、7間の平衡度が改善された弾性表面波装置が得られる。

【0083】

さらに、ダミー電極 $31\alpha$ を形成することで、弾性表面波がパルク波に変換されることによる損失の増加を防ぎ、通過帯域内の挿入損失の良好な弾性表面波装置が得られる。また、ダミー電極 $31\alpha$ は接地せずに浮き電極としてもよいが、浮き電極は平衡信号端子6、7間の平衡度が悪化する原因となるので、接地しておいた方が良い。

【0084】

しかし、図3の構成では、間引き重み付けを行うことにより、無電界部 $9$ がIDT1とIDT40とが並ぶ側より、IDT1とIDT3とが並ぶ側の方が大きくなってしまう。これではまだ、十分な平衡信号端子6、7間の平衡度が得られない。そこで、図4に示すように、IDT1とIDT2とが並ぶ側のシグナル電極指 $22$ に交叉幅重み付けを施した交叉重み付け電極指 $22\alpha$ を設定し、さらにダミー電極 $21\alpha$ を設けた。これによりIDT1とIDT2との間の境界部 $X_1$ 、及び、IDT1とIDT8との間の境界部 $X_2$ における各無電界部 $9$ 、 $9$ の大きさが互いに略一致し、平衡信号端子間の平衡度がさらに改善された、弾性表面波装置が得られる。

【0085】

さらにダミー電極 $21\alpha$ を形成することで、弾性表面波がパルク波に変換されることによる損失の増加を防ぎ、通過帯域内の挿入損失の良好な、弾性表面波装置が得られる。

【0086】

このような接地されたダミー電極 $21\alpha$ 、 $31\alpha$ は、互いに隣り合う各アース電極指 $21$ 、 $31b$ との間で無電界部 $9$ をそれぞれ形成しており、後述するように上記各無電界部 $9$ の形成領域（容量の形成領域）の大きさを制御できるようになっている。

【0087】

以上説明したような交叉重み付けは、シグナル電極に施す方が少ない重み付けで無電界部

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を調整できるので効率的であるが、もちろんアース電極に重み付けされてもよい。

【0088】

また、重み付けは本実施の第一形態においては入力用のIDT1と出力用のIDT2、3が互いに隣り合う箇所の電極指、及び、その電極指から2本目の電極指を行ったが、これはIDTのどの部分で行ってもよい。しかし、IDTが隣り合う電極指の極性の差によって影響が大きい、通過帯域の最も高周波側にある共振モード（図72のCの共振モード）は、図72（b）で示すようにIDTが隣り合う箇所において電流の分布が大きいので、図4に示すように、各IDT1、2が互いに隣り合う箇所から、IDT2における弹性表面波の伝搬方向長さの1/2の範囲内まで行うのが、効果的である。

【0089】

また、交叉幅重み付けは、実施の第一形態では、シグナル電極指22を略中央部まで短くした交叉重み付け電極指22aを設定することにより実施されているが、交叉幅重み付けの量は、必要に応じて調整すればよい。例えば、IDT1側のシグナル電極指22に約1/4の交叉幅重み付けを行い、さらに、次のシグナル電極指22にも約1/4の交叉幅重み付けを実施しても、同様な効果が得られる。

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【0090】

図5に、本実施の第一形態の構成での周波数に対する平衡信号端子6、7間の振幅平衡度、図6に位相平衡度を示す。また比較として、図2に示した第一比較例の構成における周波数に対する平衡信号端子間の振幅平衡度を図7に、位相平衡度を図8に示す。EGSM送信用フィルタの通過帯域の周波数範囲は880MHz～915MHzである。

【0091】

この範囲での周波数に対する平衡信号端子6、7間の振幅平衡度は、第一比較例では-1.6dB～+1.5dB（偏差3.1dB、偏差が小さければ、振幅平衡度は良い）であるのに対し、本実施の第一形態では-0.7dB～+1.2dB（偏差1.9dB）と、約1.2dB改善されている。平衡信号端子6、7間の位相平衡度は第一比較例では172度～189度（偏差17度、偏差が小さければ、位相平衡度は良い）であるのに対し、本実施の第一形態では178度～184度（偏差6度）と、約11度改善されている。

【0092】

以上説明したように本実施の第一形態では、1つの縦結合共振子型弹性表面波フィルタを用いて平衡-不平衡変換機能を有する弹性表面波装置の構成に重み付けを施すことで、従来の弹性表面波装置よりも平衡信号端子6、7間の平衡度が改善された、弹性表面波装置が得られる。

【0093】

本実施の第一形態では、3つのIDTを有する縦結合共振子型弹性表面波フィルタを1つ用いる構成で説明したが、本発明はこの構成に限らず、平衡信号端子6、7を有する弹性表面波フィルタを用いた弹性表面波装置であれば、どのような構成においても、同様な効果が得られる。

【0094】

例えば図9は、5つのIDTを有する縦結合共振子型弹性表面波フィルタを用いた平衡-不平衡変換機能を有する弹性表面波装置であるが（平衡信号端子401、402、不平衡信号端子403）、このように3つ以上のIDTを有する縦結合共振子型弹性表面波フィルタを用いた構成や、2つのIDTを有する縦結合共振子型弹性表面波フィルタを用いた構成においても、本発明の効果は得られる。もちろん、縦結合共振子型弹性表面波フィルタだけに限らず、トランスパーサル型の弹性表面波フィルタや、横結合共振子型弹性表面波フィルタを用いた弹性表面波装置においても、同様に効果が得られる。

【0095】

また本実施の第一形態では、平衡-不平衡変換機能を有する弹性表面波装置で説明したが、例えば図10（平衡信号端子501と平衡信号端子502とが対、平衡信号端子503と平衡信号端子504とが対となっている）や図11（平衡信号端子601と平衡信号端子602とが対、平衡信号端子603と平衡信号端子604とが対となっている）に示し

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左、平衡信号入力ー平衡信号出力の弹性表面波装置においても、本発明の効果は得られる。

【0096】

また、本実施の第一形態では、1つの縦結合共振子型弹性表面波フィルタを用いて平衡ー不平衡変換機能を有する弹性表面波装置を構成する例で説明したが、本発明はこの構成だけではなく、あらゆる平衡ー不平衡変換機能を有する弹性表面波装置において、効果が得られる。

【0097】

例えば図12のように、1つの縦結合共振子型弹性表面波フィルタにおける1つのIDTの両極のくし歯状電極にそれぞれ平衡信号端子701、702が接続され(703が不平衡信号端子)、アースに接地された電気的中性点を有さない構成、さらに図13のように、いずれかのIDTが交叉幅方向に分割され、インピーダンスが変更された構成(801、802が平衡信号端子、803が不平衡信号端子)、さらに図14のように、弹性表面波の伝搬方向に分割され、分割したくし歯状電極のそれぞれに平衡信号端子901、902を接続する構成(903が不平衡信号端子)においても、本発明の効果は得られる。

【0098】

その際、図15に示すように、不平衡信号端子1008を左右のIDTにおいてそれぞれ別方向のくし歯状電極に接続することで、さらに通過帯域外の減衰量が改善された、弹性表面波装置が得られる(1001、1002が平衡信号端子)。

【0099】

さらに、複数の縦結合共振子型弹性表面波フィルタを組み合わせて、平衡ー不平衡変換機能を有する弹性表面波装置の構成においても、本発明の効果は得られる。

【0100】

例えば図16のように、縦結合共振子型弹性表面波フィルタ1104に対して縦結合共振子型弹性表面波フィルタ1105の入力信号に対する出力信号の位相を約180度異らせ、かつ、平衡信号端子1101、1102につながるIDTを直列接続、不平衡信号端子1108につながるIDTを並列接続して、平衡ー不平衡変換機能を備えた弹性表面波装置の構成、さらに図17のように図16の構成に1つの縦結合共振子型弹性表面波フィルタ1201をカスケード接続した構成、また、図18のように、図68の構成に重み付けを施しても、本発明の効果は得られる。

【0101】

このように、さらに縦結合共振子型弹性表面波フィルタをカスケード接続する構成では、平衡信号端子間の平衡度が改善されるだけではなく、通過帯域外の減衰量が大きい弹性表面波装置が得られる。その際、図19のように、カスケード接続しているそれぞれ2つの縦結合共振子型弹性表面波フィルタを接続している各シグナルライン1301、1302を伝送する電気信号の位相が互いに約180度異なるように、各IDT1303、1304を互いに反転させ、同様に、各シグナルライン1305、1306を伝送する電気信号の位相が互いに約180度異なるように、各IDT1307、1308を互いに反転させることで、さらに平衡信号端子間の平衡度を改善した、弹性表面波装置が得られる。

【0102】

さらに図20のように、図12の弹性表面波装置にさらに1つの縦結合共振子型弹性表面波フィルタ1401をカスケード接続した構成でも、本発明の効果は得られる。この構成では、平衡信号端子間の平衡度が改善されるだけではなく、通過帯域外の減衰量が大きい弹性表面波装置が得られる。このとき図21のように、図19の構成と同様に各シグナルライン1501、1502を伝送する電気信号の位相が互いに約180度異なるように各IDT1503、1504を互いに反転させることで、さらに平衡信号端子間の平衡度を改善した、弹性表面波装置が得られる。

【0103】

また、2つ以上の縦結合共振子型弹性表面波フィルタをカスケード接続する場合は、特に同じ構成の縦結合共振子型弹性表面波フィルタを用いる必要はなく、例えば入出力でイン

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ピーダンスを調整したい場合は交叉幅を調整する、或いは、通過帯域外の減衰量を大きくしたい場合は I D T の対数や隣り合う I D T 同士の中心間距離、I D T と反射器の中心間距離を異ならせるなど、各弹性表面波フィルタで設計を異ならせてもよい。

【0104】

また、本実施の第一形態では、いずれの縦結合共振子型弹性表面波フィルタにおいても、各 I D T の電極指総本数を奇数本としたが、これは偶数本であってもよく、特に図 22 のように、8つある I D T の中央部に位置し、さらに平衡信号端子に接続される I D T の電極指の総本数を偶数本とすることでも、本発明の効果が得られる。

【0105】

この場合、縦結合共振子型弹性表面波フィルタの中心に対して左右の対称性が向上し、さらに平衡信号端子に接続されている電極指の本数が等しくなるので、より平衡信号端子間の平衡度が改善された、弹性表面波装置が得られる。

【0106】

また図 23 に示すように、弹性表面波共振子 1601、1602 を直列接続した構成や、図示しないが弹性表面波共振子を並列接続した構成、あるいはその両方を接続した構成においても、本発明の効果は得られる。この構成の場合、平衡信号端子間の平衡度が改善されるだけではなく、特に通過帯域近傍の減衰量が大きい弹性表面波装置が得られる。

【0107】

(実施の第二形態)

本実施の第二形態について、図 24 乃至図 28 に基づいて説明すれば以下の通りである。なお、本実施の第二形態においては、図 1 にて示した弹性表面波装置と同様な機能を有する部材については同一の部材番号を付与してその説明を省いた。

【0108】

本実施の第二形態に係る弹性表面波装置では、重み付けの方法として、図 24 に示すように、上記実施の第一形態での、間引き重み付け及び交叉幅での交叉重み付けに代えて、直列重み付けが用いられている。つまり、上記実施の第一形態に記載の I D T 2 に代えて、I D T 25 が設けられている。

【0109】

I D T 25 では、前述の I D T 2 のダミー電極 21a に代えて、交叉重み付け電極指 22a の内側の(次の)アース電極指 21 を交叉重み付け電極指 22a と同様に短くした交叉重み付け電極指(第二バランス用電極指) 21b が設けられ、さらに、上記両者と離間(つまり浮いた状態)しているダミー電極 25a が設けられている。

【0110】

上記ダミー電極 25a は、交叉重み付け電極指 22a と同幅にて、交叉重み付け電極指 22a と次のシグナル電極指 22 との間を、それらとほぼ平行に延び、続いて、交叉重み付け電極指 22a の先端部と交叉重み付け電極指 21b の先端部との間を通り、さらに、交叉重み付け電極指 21b と最外のアース電極指 21 との間を、それらとほぼ平行に延びるように折れ曲がって形成される電極指である。

【0111】

このような I D T 25 を有する弹性表面波装置について、通過帯域近傍の、振幅平衡度及び位相平衡度をそれぞれ測定した。それらの結果を図 25 及び図 26 にそれぞれ示した。それらの結果から明らかに、EGSM 送信用フィルタの通過帯域の範囲における周波数 - 平衡信号端子間の振幅平衡度は -0.7 dB ~ +1.2 dB (偏差 1.9 dB) と実施の第一形態と同じであるが、平衡信号端子間の位相平衡度は 177 度 ~ 182 度(偏差 5 度)と、実施の第一形態よりもさらに 1 度改善されている。

【0112】

さらに、実施の第一形態における周波数に対する通過帯域内の伝送特性を図 27 に示し、実施の第二形態における周波数に対する通過帯域内の伝送特性を図 28 に示した。上記両者を比較すると、実施の第一形態では通過帯域内にリップル A(図 27 参照)が発生しているが、実施の第二形態においては、上記リップル A が発生しておらず(図 28 参照)、

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実施の第一形態よりも通過帯域内の偏差が小さい弹性表面波装置が得られている。

【0118】

以上説明したように、交叉幅重み付けをさらに拡張した直列重み付けを実施することで、さらに平衡信号端子間の平衡度、および通過帯域内の偏差が改善された、弹性表面波装置が得られる。

【0114】

その上、本実施の第二形態では、前記実施の第一形態と比べても、伝送特性においてリップルの発生が抑制されており、より優れた伝送特性を有していることが判る。

【0115】

(実施の第三形態)

本発明の実施の第三形態について図29乃至図32に基づいて説明すれば、以下の通りである。図29に、本発明の実施の第一形態に係る構成を示す。なお、本実施の第三形態では、PC8受信用フィルタを例にとって説明を行う。

【0116】

本実施の第三形態の弹性表面波装置では、圧電基板200上に、IDTの縦結合共振子型の弹性表面波フィルタ201と、弹性表面波フィルタ201に直列接続された各弹性表面波共振子202、208とがフォトリソグラフィー法等により形成されたアルミニウム(AI)電極(箔)によって形成されている。上記圧電基板200の素材としては、40±5°YcutX伝搬LiTaO<sub>3</sub>が挙げられる。このような弹性表面波フィルタ201は、前述の図10に示したものとほぼ同一のものである。

【0117】

弹性表面波フィルタ201においては、中心となり、平衡信号端子側となるIDT205を左右から挟み込むように(弹性表面波の伝搬方向に沿って)各IDT204、206がそれぞれ形成されている。さらに、各IDT204、206の両外側(弹性表面波の伝搬方向に沿って)に、上記各IDT204～206からの弹性表面波を反射する各反射器207、208がそれぞれ形成されている。つまり、各IDTや反射器は、各電極指の幅方向が弹性表面波の伝搬方向に沿うように、かつ、上記弹性表面波の伝搬路上に設定されている。

【0118】

さらに、弹性表面波フィルタ201では、図29から明らかなように、IDT204とIDT205とが互いに隣り合う箇所およびそれらの近傍、並びにIDT205とIDT206とが互いに隣り合う箇所およびそれらの近傍の、数本の電極指(狭ピッチ電極指)のピッチを、前述と同様に、上記各IDTの他の部分よりも小さくなるように設定している(図29の218と214の箇所)。

【0119】

上記弹性表面波装置においては、各端子210、211が平衡信号端子、端子209が不平衡信号端子である。よって、IDT204、IDT206は、不平衡信号側となり、それぞれ、シグナル電極指204aおよびアース電極指204b、シグナル電極指206aおよびアース電極指206bを備えている。一方、IDT205は、平衡信号端子側となり、各シグナル電極指205a、205bを備えていることになる。よって、本実施の第三形態は、アースに接地された電気的中性点を有さない構成に重み付けを施した例である。

【0120】

各弹性表面波共振子202、208は、シグナルライン212を介して、不平衡信号端子209と各IDT204、206の間に直列接続されている。弹性表面波共振子202は、IDT202aと、それを挟むように弹性表面波の伝搬方向に沿って各反射器202b、202cとを有している。弹性表面波共振子208は、IDT208aと、それを挟むように弹性表面波の伝搬方向に沿って各反射器208b、208cとを有している。

【0121】

本実施の第三形態の特徴は、IDT205とIDT206とが互いに隣り合って、弹性表

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面波の伝搬方向にて対面している箇所における、IDT 206の電極指219の箇所にて間引き重み付けされている点である。

【0122】

本実施の第三形態では、上記間引き重み付けとして、IDT 206のシグナル電極指206aにおける、IDT 205に隣り合う箇所（最も近い方）の電極指が間引き重み付けされている。

【0123】

かつ、本実施の第三形態では、各電極指のピッチを確保して、互いに隣り合う各IDT、つまり、各IDT 205、206の間の間隔を維持するために、アース電極指206bに電極指219が、狭ピッチ側のアース電極指206bと同じ交叉幅、同ピッチ、同duつよ、および同じ線幅にて設けられている。これにより、IDT 206では、IDT 205に隣り合う箇所にて、アース電極指206bが複数、例えば2本、互いに隣り合って存在することになる。

【0124】

弾性表面波フィルタ201の詳細な設計は、狭ピッチ電極指のピッチで決まる波長を $\lambda_{I_2}$ （図29の213、214の箇所）、その他の電極指のピッチで決まる波長を $\lambda_{I_1}$ とすると、

交叉幅W: 60.6 $\lambda_{I_1}$

IDT本数（204、205、206の順）: 29(4)／(4) 44(4)／(4) 29本（カッコ内はピッチを小さくした電極指の本数）

IDT波長 $\lambda_{I_1}$ : 2.06 $\mu\text{m}$ 、 $\lambda_{I_2}$ : 1.88 $\mu\text{m}$

反射器波長 $\lambda_R$ : 2.07 $\mu\text{m}$

反射器本数: 100本

IDT-IDT間隔: 0.50 $\lambda_{I_2}$

波長 $\lambda_{I_1}$ と波長 $\lambda_{I_2}$ との各電極指にて挟まれた箇所の間隔（図29の215、216、217、218）: 0.25 $\lambda_{I_1}$  + 0.25 $\lambda_{I_2}$

IDT-反射器間隔: 0.47 $\lambda_R$

duつよ: 0.60 (IDT、反射器共)

電極膜厚: 0.080 $\lambda_{I_1}$

弾性表面波共振子202の詳細な設計を、以下に示す。

交叉幅W: 40.6 $\lambda$

IDT本数: 241本

波長 $\lambda$  (IDT、反射器共): 1.97 $\mu\text{m}$

反射器本数: 30本

IDT-反射器間隔: 0.50 $\lambda$

duつよ: 0.60 (IDT、反射器共)

電極膜厚: 0.084 $\lambda$

弾性表面波共振子203の詳細な設計を、以下に示す。

交叉幅W: 49.1 $\lambda$

IDT本数: 401本

波長 $\lambda$  (IDT、反射器共): 2.04 $\mu\text{m}$

反射器本数: 30本

IDT-反射器間隔: 0.50 $\lambda$

duつよ: 0.60 (IDT、反射器共)

電極膜厚: 0.080 $\lambda$

上記の「間隔」とは、互いに隣り合う2本の電極指の中心（幅方向での中心）間距離のことである。

【0125】

次に、本実施の第三形態の各特性を測定し、それらの結果を図80および図81に示す。

本実施の第三形態の構成における、周波数に対する平衡信号端子間の振幅平衡度の測定結

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果を示すグラフを図30に、位相平衡度のグラフを図31に示す。

【0126】

比較として、図32に示す、2つのIDTが隣り合っている箇所において間引き重み付けが施されていないIDT206cを、IDT206に代えて有する、第二比較例の構成での振幅平衡度、位相平衡度も図30及び図31に合わせて示す。

【0127】

図32の第二比較例の構成は、実施の第三形態に対して、間引き重み付けを施していないIDT206cをIDT206に代えて有する以外は全く同じ構成である。PC8受信用フィルタにおける通過帯域の周波数範囲は1980MHz～1990MHzである。

【0128】

この範囲での最大の振幅平衡度は、第二比較例では、-1.6dB～+0.7dB（偏差2.3dB）であるのに対し、実施の第三形態では-1.5dB～+0.7dB（偏差2.2dB）と、約0.1dB振幅平衡度が改善している。次に位相平衡度は、第二比較例では、162度～182度（偏差20度）であるのに対し、実施の第三形態では162度～181度（偏差19度）と、約1度位相平衡度が改善している。

【0129】

これは間引き重み付けを施すことでの、IDT205とIDT206とが互いに隣り合う箇所での電極指の極性が、第二比較例では+と+どちらもシグナル電極指であったのが、本実施の第三形態では、IDT204とIDT205とが互いに隣り合う箇所の極性と同じ-と+となり、左右の非対称性が改善された効果である。

【0130】

以上説明したように、本実施の第三形態では、平衡-不平衡変換機能を有する弾性表面波フィルタにおいて、2つのIDTが互いに隣り合う箇所の電極指を間引き重み付けすることで、従来の弾性表面波フィルタよりも平衡信号端子間の平衡度が改善された弾性表面波フィルタが得られる。

【0131】

（実施の第四形態）

本発明の実施の第四形態を図33乃至図41に基づいて説明する。実施の第四形態では、EGSM受信用フィルタを例にとって説明を行っていく。

【0132】

実施の第四形態に係る弾性表面波装置は、図18に示した、入力信号に対する出力信号の位相が約180度異なる2つの各縦結合共振子型弾性表面波フィルタ1918、1920を平衡信号端子1906、1907側は直列接続、不平衡信号端子1905側は並列接続して平衡-不平衡変換機能を持たせ、さらに、2つの縦結合共振子型弾性表面波フィルタ1918、1920それぞれに1つずつの新た縦結合共振子型弾性表面波フィルタ1918、1918をカスケード接続した構成とし、上記縦結合共振子型弾性表面波フィルタ1920に、間引き重み付けを施し、ダミー電極1901bを有している例である。

【0133】

実施の第四形態では、圧電基板8上に4つの縦結合共振子型弾性表面波フィルタ1918、1920がA1電極により形成されている。4つの縦結合共振子型弾性表面波フィルタ1918、1920は、入力信号に対する出力信号の位相が約180度異なる点、及び重み付けされている点以外は、すべて同じ設計である。また、実施の第四形態では実施の第三形態と同様に、2つのIDTが隣り合う間に、数本狭ピッチ電極指が設けられている。実施の第四形態の構成は、重み付けの点以外、基本的には図68に示した第二従来例の構成と同じである。

【0134】

縦結合共振子型弾性表面波フィルタ1918の詳細な設計は、狭ピッチ電極指のピッチで決まる波長を $\lambda_{I2}$ 、他の電極指のピッチで決まる波長を $\lambda_{I1}$ とすると、

交叉幅:  $2.5 \cdot 2\lambda_{I1}$

IDT本数(1902、1901、1903の順): 28(4) / (4) 26(4) / 2

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3 (4) 本 (カッコ内はピッチを狭くした電極指の本数)

IDT 波長  $\lambda_{I_1}$  : 4.204 μm,  $\lambda_{I_2}$  : 3.854 μm

反射器波長  $\lambda_R$  : 4.279 μm

反射器本数 : 90 本

IDT - IDT 間隔 :

波長  $\lambda_{I_1}$  と波長  $\lambda_{I_2}$  の電極指に挟まれた箇所 : 0.25  $\lambda_{I_1}$  + 0.25  $\lambda_{I_2}$

波長  $\lambda_{I_2}$  の電極指に挟まれた箇所 : 0.50  $\lambda_{I_2}$

IDT - 反射器間隔 : 0.470  $\lambda_R$

IDT  $d_{uty}$  : 0.720

反射器  $d_{uty}$  : 0.55

電極膜厚 : 0.08  $\lambda_{I_1}$  である。

#### 【0135】

実施の第四形態の特徴は、縦結合共振子型弹性表面波フィルタ1918に対して縦結合共振子型弹性表面波フィルタ1920の入力信号に対する出力信号の位相を約180度異なるために反転させたIDT1901の両端に位置し、不平衡信号端子1905と接続された電極指の片方が間引かれてその部分にアースに接続されたダミー電極1901bを設けている点である。

#### 【0136】

次に、本実施の第四形態の作用・効果について説明する。図84に、実施の第四形態の構成での周波数に対する平衡信号端子間の振幅平衡度を示す。比較として、図68の第二従来例での周波数に対する平衡信号端子間の振幅平衡度も図84に示す。図68の第二従来例の構成は実施の第四形態に対して、間引き重み付けを施していない以外は、全く同じ構成である。EGSM受信用フィルタにおける通過帯域の周波数範囲は925MHz～960MHzである。

#### 【0137】

この範囲での平衡信号端子間の振幅平衡度は、第二従来例では-0.2dB～+1.8dB (偏差1.5dB) であるのに対し、実施の第四形態では-0.7dB～+0.2dB (偏差0.9dB) と、約0.6dB振幅平衡度が改善している。

#### 【0138】

以下に、実施の第四形態の効果が得られた理由を説明する。弹性表面波の励振は、極性の異なる電極指が隣接する場合に、その電極指間で行われる。図85に、図68に記載の各弹性表面波フィルタ118、127における、IDT同士が隣接する周辺 (図68で○で囲った部分) での弹性表面波の励振状態について図示する。

#### 【0139】

図85では、それぞれIDTが隣接する部分の端から8本の電極指のみを示し、その他については省略している。図68の縦結合共振子型弹性表面波フィルタ118、127は、図85では縦結合共振子型弹性表面波フィルタ2007、2008に、図68のIDT118、114、115は、図85においてはIDT2001、2002、2003に、図68のIDT133、134、135は、図85のIDT2004、2005、2006にそれぞれ対応している。図中で○をついている部分では、弹性表面波が励振され、×をついている部分では、弹性表面波は励振されないことを示す。

#### 【0140】

第二従来例の場合、縦結合共振子型弹性表面波フィルタ2007において、IDT2001、2002、2003それぞれの最外電極指はアース電極であるため、それぞれの隣接する電極指間では弹性表面波の励振は行われない。

#### 【0141】

一方、縦結合共振子型弹性表面波フィルタ2008においては、縦結合共振子型弹性表面波フィルタ2007のIDT2001と向きを反転させたIDT2004によって、縦結合共振子型弹性表面波フィルタ2007との入力信号に対する出力信号の位相を約180

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度異ならせているため、IDT 2004 の最外電極指はシグナル電極であり、IDT 2005、2006 の最外電極指はアース電極である。

【0142】

そのため、縦結合共振子型弾性表面波フィルタ 2008 においては、縦結合共振子型弾性表面波フィルタ 2007 の場合とは異なり、それぞれの隣接する電極指間にあっても弾性表面波の励振が行われ、全体で比較すると、縦結合共振子型弾性表面波フィルタ 2007 に比べて、縦結合共振子型弾性表面波フィルタ 2008 では弾性表面波の励振が行われる箇所が 2 箇所多くなる。

【0143】

これにより、第二従来例においては、縦結合共振子型弾性表面波フィルタ 2007 と縦結合共振子型弾性表面波フィルタ 2008 とで、隣接する電極指間隔部における弾性表面波の有効電流の強度分布が異なり、その結果、図 72 に示す 3 つの共振モードのうち、中央に位置する共振モードと最も高域側に位置する共振モードの間隔が異なり、平衡信号端子間の平衡度が悪化していた。

【0144】

次に、図 86 に、図 88 に示す縦結合共振子型弾性表面波フィルタ 1918、1920 における、IDT 同士が隣接する周辺（図中で○で囲った部分）での弾性表面波の励振状態について図示する。図 86 においても図 85 と同様に、それぞれ IDT が隣接する部分の端から 3 本の電極指のみを示し、その他については省略している。

【0145】

図 88 における縦結合共振子型弾性表面波フィルタ 1918、1920 は、図 86 の縦結合共振子型弾性表面波フィルタ 2107、2108 に、また、図 88 における縦結合共振子型弾性表面波フィルタ 1918 の IDT 1902、1901、1903 は、図 86 の IDT 2102、2101、2108 に、図 88 における縦結合共振子型弾性表面波フィルタ 1920 の IDT 1901a、1902、1903 は、図 86 の IDT 2104、2105、2106 にそれぞれ対応している。

【0146】

実施の第四形態の場合には、入力側に接続された IDT の向きを反転することで、縦結合共振子型弾性表面波フィルタ 2107 と入力信号に対する出力信号の位相を約 180 度異ならせた縦結合共振子型弾性表面波フィルタ 2108 において、IDT 2104 の最外電極指を間引き重み付けし、その部分にダミーの電極 2109（図 88 のダミー電極 1901b）を設け、アースに接続している。

【0147】

このため、縦結合共振子型弾性表面波フィルタ 2108 では、一方の 2 つの IDT が隣接する部分 2110 において、シグナル電極指とアース電極指が交互に並ぶため弾性表面波が励振されるのに対し、もう一方の 2 つの IDT が隣接する部分 2111 において、アース電極指が 3 本並ぶために弾性表面波が励振されない部分が 2 箇所発生する。

【0148】

その結果、縦結合共振子型弾性表面波フィルタ 2107 と縦結合共振子型弾性表面波フィルタ 2108 において、電極指間で弾性表面波が励振されない箇所の総数、すなわち電極指間で弾性表面波が励振される箇所の総数が等しくなるため、第二従来例と比較して共振モードの間隔の差が小さくなり、平衡信号端子間での振幅平衡度が改善される。

【0149】

例えば、図 87 に示すような縦結合共振子型弾性表面波フィルタ 2201 を 2 段縦続に接続した第 1 の縦結合共振子型弾性表面波フィルタ 2202 と、第 1 の縦結合共振子型弾性表面波フィルタ 2202 に対して 2 段目の出力側に接続される縦結合共振子型弾性表面波フィルタ 2201a の IDT 2203 の向きを反転することで、第 1 の縦結合共振子型弾性表面波フィルタ 2202 とは入力信号に対する出力信号の位相を約 180 度異ならせた第 2 の縦結合共振子型弾性表面波フィルタ 2204 とを有し、1 段目の各縦結合共振子型弾性表面波フィルタ 2201 における中央の IDT を並列に接続し不平衡信号端子 220

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5を、2段目の各縦結合共振子型弹性表面波フィルタ2201、2201αの中央のIDTを直列に接続し平衡信号端子2206を構成した場合がある。

【0150】

上記場合でも、IDT2208の最外電極指を間引き重み付けして、その部分にダミー電極2207を設けアースに接続することで、出力側の縦結合共振子型弹性表面波フィルタにおける2つのIDTが隣接する周辺（図37中の○で囲った部分）での弹性表面波の励振状態は図38のようになり、第1の縦結合共振子型弹性表面波フィルタ2202と第2の縦結合共振子型弹性表面波フィルタ2204において、電極指間で弹性表面波が励振されない箇所の総数、すなわち電極指間で弹性表面波が励振される箇所の総数が互いに等しくなるため、平衡信号端子間の振幅平衡度が改善される。

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【0151】

また、図39に示すように、2段目の縦結合共振子型弹性表面波フィルタの中央IDTではなく、外側のIDTの向きを反転することで入力信号に対する出力信号の位相を約180度異なる場合もある。

【0152】

上記場合においても、向きを反転させたIDT2301の片方のIDTの最外電極指を間引き重み付けして、その部分にダミーの電極指2302を設けてアースに接続することで、出力側の縦結合共振子型弹性表面波フィルタにおける2つのIDTが隣接する周辺（図39の○で囲った部分）での弹性表面波の励振状態は、図40に示すように、第1の縦結合共振子型弹性表面波フィルタ2303と第2の縦結合共振子型弹性表面波フィルタ2304において、電極指間で弹性表面波が励振されない箇所の総数、すなわち電極指間で弹性表面波が励振される箇所の総数が互いに等しくなるため、平衡信号端子間での振幅平衡度が改善される。

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【0153】

また、図41に示すように、図38における3IDTタイプの縦結合共振子型弹性表面波フィルタの代わりに5IDTタイプの縦結合共振子型弹性表面波フィルタを用いて構成した場合においても、向きを反転させたIDT2401のIDTの片側の最外電極指を間引き重み付けして、その部分にダミーの電極指2402を設けてアースと接続することで、第1の縦結合共振子型弹性表面波フィルタ2403と第2の縦結合共振子型弹性表面波フィルタ2404において、電極指間で弹性表面波が励振されない箇所の総数、すなわち電極指間で弹性表面波が励振される箇所の総数が互いに等しくなるため、平衡信号端子間での振幅平衡度が改善される。

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【0154】

以上、説明したように実施の第四形態では、入力信号に対する出力信号の位相が約180度異なる2つの弹性表面波フィルタを平衡信号端子側は直列接続、不平衡信号端子側は並列接続して平衡-不平衡変換機能を持たせ、さらに2つの弹性表面波フィルタそれぞれに1つずつの弹性表面波フィルタをカスケード接続した構成に間引き重み付けを施することで、従来の弹性表面波装置よりも平衡信号端子間の平衡度が改善された弹性表面波装置が得られる。

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【0155】

（実施の第五形態）

本発明の実施の第五形態を図42乃至図46に基づいて説明する。本実施の第五形態では、DCS受信用フィルタを例にとって説明を行っていく。

【0156】

実施の第五形態は図16に示した、入力信号に対する出力信号の位相が約180度異なる2つの縦結合共振子型弹性表面波フィルタを平衡信号端子側は直列接続、不平衡信号端子側は並列接続して平衡-不平衡変換機能を持たせた構成に、重み付けを施した例である。

【0157】

実施の第五形態では、前述の圧電基板8上に縦結合共振子型弹性表面波フィルタ2501と、縦結合共振子型弹性表面波フィルタ2501に直列接続された弹性表面波共振子25

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02と2503が、AI電極により形成されている。2つの縦結合共振子型弾性表面波フィルタは、入力信号に対する出力信号の位相が約180度異なる以外は、すべて同じ設計である。また、実施の第五形態では実施の第三形態と同様に、2つのIDTが隣り合う間に、数本の狭ピッチ電極指が設けられている。

【0158】

縦結合共振子型弾性表面波フィルタの詳細な設計は、狭ピッチ電極指のピッチで決まる波長を $\lambda_{I_2}$ 、その他の電極指のピッチで決まる波長を $\lambda_{I_1}$ とすると、

交叉幅: 87.12 $\lambda_{I_1}$

IDT本数(2504、2505、2506の順): (4)19/(4)81(4)/19(4)本(カッコ内はピッチを狭くした電極指の本数)

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IDT波長 $\lambda_{I_1}$ : 2.156 $\mu\text{m}$ 、 $\lambda_{I_2}$ : 1.926 $\mu\text{m}$

反射器波長 $\lambda_R$ : 2.177 $\mu\text{m}$

反射器本数: 150本

IDT-IDT間隔: 波長 $\lambda_{I_1}$ と $\lambda_{I_2}$ の電極指に挟まれた箇所: 0.25 $\lambda_{I_1}$ +0.25 $\lambda_{I_2}$ 、波長 $\lambda_{I_2}$ の電極指に挟まれた箇所: 0.50 $\lambda_{I_2}$

IDT-反射器間隔: 0.50 $\lambda_R$

IDT duty: 0.68

反射器duty: 0.60

電極膜厚: 0.09 $\lambda_{I_1}$

弾性表面波共振子2502の詳細な設計を、以下に示す。

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交叉幅: 14.8 $\lambda_I$

IDT本数: 241本

IDT波長および反射器波長: 2.102 $\mu\text{m}$

反射器本数: 80本

IDT-反射器間隔: 0.50 $\lambda_R$

弾性表面波共振子2503の詳細な設計を、以下に示す。

交叉幅: 87.1 $\lambda_I$

IDT本数: 241本

IDT波長および反射器波長: 2.028 $\mu\text{m}$

反射器本数: 80本

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IDT-反射器間隔: 0.50 $\lambda_R$ である。

【0159】

実施の第五形態の特徴は、弾性表面波フィルタ2507に対して弾性表面波フィルタ2508の入力信号に対する出力信号の位相を約180度異ならせるために反転させた、IDT2509の端に位置するシグナル電極指の片方が間引かれて、その部分にアースに接続されたダミー電極2510を設けており、さらにダミー電極2510を介して3つの各IDTのアース電極を共通化している点である。

【0160】

次に、本実施の第五形態の作用・効果について説明する。まず、図48に実施の第五形態の構成での周波数に対する平衡信号端子間の振幅平衡度を示す。比較として図44に示す、第三比較例での周波数に対する平衡信号端子間の振幅平衡度も図48に合わせて示す。図44の第三比較例の構成は実施の第五形態に対して、間引き重み付けを施していない以外は、全く同じ構成である。

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【0161】

DCS受信用フィルタにおける通過帯域の周波数範囲は1805MHz～1880MHzである。この範囲での平衡信号端子間の振幅平衡度は、第三比較例では、-1.0dB～+8.2dB(偏差4.2dB)であるのに対し、実施の第五形態では-0.5dB～+1.5dB(偏差2.0dB)と、約2.2dB振幅平衡度が改善している。

【0162】

実施の第五形態の効果が得られた理由を説明すると、図44に示す第三比較例では図45

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に示すように、IDT同士が隣接する周辺（図44の○で囲った部分）での弾性表面波が励振される箇所の数が第1の弾性表面波フィルタ2601と第2の弾性表面波フィルタ2602とで異なるのに対し、実施の第五形態の場合には、図46に示すように、IDT同士が隣接する周辺（図42の○で囲った部分）での弾性表面波が励振される箇所の数が第1の縦結合共振子型弾性表面波フィルタ2511と第2の弾性表面波フィルタ2512とで同じになる。このために、図72に示す3つの共振モードのうちにおける、帯域中央に見られる共振モードと帯域高域側に見られる共振モードの間隔が、2つの平衡信号端子から出力される信号間で、第三比較例より一致したためである。

#### 【0168】

以上の様に実施の第五形態では、入力信号に対する出力信号の位相が約180度異なる2つの縦結合共振子型弾性表面波フィルタを平衡信号端子側は直列接続、不平衡信号端子側は並列接続して平衡-不平衡変換機能を持たせた構成に間引き重み付けを施することで、従来の弾性表面波装置よりも平衡信号端子間の平衡度が改善された、弾性表面波装置が得られる。

#### 【0164】

さらに間引かれた位置に設けられたダミー電極2510も含めて3つの各IDTのアースを共通化することで、弾性表面波装置のアースが強化され、通過帯域内の挿入損失や通過帯域外の減衰量が改善される。さらに、中央部のIDTのアース端子を省略することも可能となる。

#### 【0165】

##### （実施の第六形態）

本発明に係る実施の第六形態を図47乃至図54に基づいて説明する。本実施の第六形態では、DCS受信用フィルタを例にとって説明を行っていく。

#### 【0166】

実施の第六形態は実施の第三形態と同じく、1つの縦結合共振子型弾性表面波フィルタ2701における1つのIDT2704の両極となるくし歯状電極にそれぞれ平衡信号端子2711、2712が接続され、各平衡信号端子2711、2712においては、アースに接続された電気的中性点を有さない構成に重み付けを施した例である。

#### 【0167】

実施の第六形態では、前述した圧電基板8上に縦結合共振子型弾性表面波フィルタ2701と、縦結合共振子型弾性表面波フィルタ2701に直列接続された弾性表面波共振子2702と2708がA1電極により形成されている。

#### 【0168】

縦結合共振子型弾性表面波フィルタ2701の構成は、IDT2704の左右にIDT2705、2706を配置し、これらのIDTを挟み込むように、反射器2707、2708が形成されている。

#### 【0169】

実施の第六形態では実施の第三形態と同様に、2つのIDTが隣り合う間に、数本の狭ピッチ電極指が設けられている（図47の2709と2710の箇所）。端子2711と2712は平衡信号端子、2713は不平衡信号端子である。図48に、図47のIDT2704と2705の間を拡大した図を示す。

#### 【0170】

平衡信号端子2711に接続されたIDT2704の最外電極指2704aが交叉幅重み付けされ、さらに重み付けされて、削除された箇所にダミー電極2705aが設けられ、アースに接続されている。

#### 【0171】

縦結合共振子型弾性表面波フィルタ2701の詳細な設計は、狭ピッチ電極指のピッチで決まる波長を $\lambda_{I2}$ 、他の電極指のピッチで決まる波長を $\lambda_{I1}$ とすると、

交叉幅：交叉幅重み付けしない部分（図48の2805）： $71.2\lambda_{I1}$

交叉幅重み付けした部分（図48の2806）： $85.6\lambda_{I1}$

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I D T 本数 (2705、2704、2706の順) : 21 (4) / (4) 35 (4) / (4) 21 本 (カッコ内はピッチを小さくした電極指の本数)

I D T 波長  $\lambda_{I_1}$  : 2.18  $\mu\text{m}$ 、 $\lambda_{I_2}$  : 1.96  $\mu\text{m}$

反射器 波長  $\lambda_R$  : 2.18  $\mu\text{m}$

反射器 本数 : 150 本

I D T - I D T 間隔 : 波長  $\lambda_{I_1}$  と  $\lambda_{I_2}$  の電極指に挟まれた箇所 (図47の2714) : 0.25  $\lambda_{I_1}$  + 0.25  $\lambda_{I_2}$

波長  $\lambda_{I_2}$  の電極指に挟まれた箇所 (図47の2715) : 0.50  $\lambda_{I_2}$

I D T - 反射器 間隔 : 0.460  $\lambda_R$

I D T duty : ピッチを狭くしていない部分 : 0.68、ピッチを狭くした部分 : 0.60

反射器 duty : 0.57

電極膜 厚 : 0.09  $\lambda_{I_1}$

弾性表面波共振子 2702 の詳細な設計を、以下に示す。

交叉幅 : 28.6  $\lambda_I$

I D T 本数 : 241 本

I D T 波長 および 反射器 波長 : 2.12  $\mu\text{m}$

反射器 本数 : 80 本

I D T - 反射器 間隔 : 0.50  $\lambda_R$

弾性表面波共振子 2703 の詳細な設計を、以下に示す。

交叉幅 : 58.5  $\lambda_I$

I D T 本数 : 241

I D T 波長 および 反射器 波長 : 2.04  $\mu\text{m}$

反射器 本数 : 80 本

I D T - 反射器 間隔 : 0.50  $\lambda_R$  である。

### 【0172】

実施の第六形態の特徴は、アース電極指と隣接し、平衡信号端子に接続された中央のI D T 2704の両端に位置する電極指をそれぞれ交叉幅重み付けした交叉重み付け電極指 2704aを形成し、さらに交叉幅重み付けされた箇所にダミー電極 2705a、2706aがそれぞれ設けられて、アースに接続されている点である。

### 【0173】

次に、本実施の第六形態の作用・効果について説明する。図49に、実施の第六形態の構成での周波数に対する平衡信号端子間の振幅平衡度を示す。比較として図50に示す、第四比較例での周波数に対する平衡信号端子間の振幅平衡度も図49に合わせて示す。図50の第四比較例の構成は、実施の第六形態に対して中央I D Tの両端の電極指が交叉幅重み付けされていない、縦結合共振子型弾性表面波フィルタ 2701aを用いた以外は、全く同じ構成である。DCS受信用フィルタにおける通過帯域の周波数範囲は1805MHz～1880MHzである。

### 【0174】

この範囲での平衡信号端子間の振幅平衡度は、第四比較例では-1.3dB～+3.3dB (偏差4.6dB) であるのに対し、実施の第六形態では-2.0dB～+1.9dB (偏差3.9dB) と、約0.7dB 振幅平衡度が改善している。

### 【0175】

さらに第四比較例では、平衡信号端子間の振幅平衡度が+側に大きく外れているが、実施の第六形態では+方向と-方向のずれがほぼ均等になっている。実施の第六形態のように+方向と-方向のずれがほぼ均等な方が、+側か-側のどちらか一方に大きく外れているよりも同相信号のノイズレベルが小さくなるというメリットがあり、実施の第六形態の方が、この点でも優れている。

### 【0176】

実施の第六形態の効果が得られた理由は、アース電極指と隣接する中央I D T 2704の

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両端の電極指を交叉幅重み付けし、さらに交叉幅重み付けされた箇所にダミー電極を設けてアースに接続することにより、平衡信号端子 2711 に接続される I D T と平衡端子 2712 に接続される I D T の両端の電極指がアース電極指と隣接するようになるため、それぞれに隣接する電極指との極性の関係が同じになったためである。

## 【0177】

次に、交叉幅重み付けの最適値を調査した結果について説明する。調査の方法は、図 47、図 48 の構成で、交叉幅重み付けしない部分の交叉幅 2805 に対する重み付けする部分の交叉幅 2806 の割合（以後、交叉幅重み付けの比）を変化させていく、それに伴う通過帯域内で平衡信号端子間の振幅平衡度の変化を調査した。

## 【0178】

交叉幅重み付けの比は、重み付けしない図 50 の場合を 1、図 47 の場合を 1/2 として、交叉幅重み付けの比が 1/4、1/2、3/4 の場合について、平衡信号端子間の振幅平衡度を調査した。図 51 に、交叉幅重み付けの比を変化させたときの平衡信号端子間ににおける振幅平衡度の結果値を示す。図 51 では、平衡信号端子間の振幅平衡度は、+ 側のずれ分をプロットしている。

## 【0179】

図 51 より、交叉幅重み付けの比を略 0.5 とした場合、すなわち、電極指の略中央の位置で重み付けした場合に通過帯域内の平衡信号端子間の振幅平衡度は最小となる。これは、中央 I D T の両端の電極指を略中央の位置で重み付けし、重み付けされた電極指をアースに接続したことにより、平衡信号端子 2711 に接続される I D T と平衡信号端子 2712 に接続される I D T の両端の電極指に、アース電極指がそれぞれ全体の交叉幅の略半分で隣接するため、それぞれに隣接する電極指との極性の関係が同じになった効果である。

## 【0180】

以上、説明したように実施の第六形態では、1 つの縦結合共振子型弹性表面波フィルタにおける 1 つの I D T（好ましくは中央の I D T）の、両極のくし歯状電極に、それぞれ平衡信号端子が接続され、アースに接地された電気的中性点を有さない構成において、中央 I D T の両端の電極指を略中央の位置で交叉幅重み付けし、重み付けにより削除された位置に設けられたダミー電極をアースに接続することで、従来の弹性表面波装置よりも平衡信号端子間の振幅平衡度を改善した、弹性表面波装置が得られる。

## 【0181】

実施の第六形態では、平衡信号端子に接続された I D T の両端の電極指が、両側でアース電極指と隣接している構成で説明したが、例えば、図 52 のように片側ではアース電極指と、もう片側ではシグナル電極指と隣接している構成においても、アース電極指と隣接している側のシグナル電極指のみを交叉幅重み付けし、重み付けにより削除された位置に設けたダミー電極をアースに I D T を介して接続することで、平衡信号端子間の振幅平衡度を改善した弹性表面波装置が得られる。

## 【0182】

また、図 53 のように、2 つ以上の I D T の両極から平衡信号を取り出す構成においても、2 つの I D T それぞれの最外電極指を交叉幅重み付けし、重み付けされた電極指を I D T および反射器を介してアースに接続することで、平衡信号端子間の振幅平衡度を改善できる。

## 【0183】

実施の第六形態では、縦結合共振子型弹性表面波フィルタが 8 I D T タイプの構成で説明したが、例えば 4 つ以上の I D T を有する縦結合共振子型弹性表面波フィルタの場合にも、図 54 のように平衡信号を取り出す I D T の両端の電極指を交叉幅重み付けし、重み付けにより削除された位置に設けたダミー電極をアースに I D T を介して接続することにより、平衡信号端子間の振幅平衡度を改善できる。

## 【0184】

（実施の第七形態）

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本発明に係る実施の第七形態について図55乃至図61に基づいて説明する。本実施の第七形態では、PCS受信用フィルタを例にとって説明を行っていく。

【0185】

実施の第七形態は実施の第三形態と同じく、1つの縦結合共振子型弹性表面波フィルタの1つのIDTの両極のくし歯状電極にそれぞれ平衡信号端子が接続され、アースに接続された電気的中性点を有さない構成に重み付けを施した例である。

【0186】

実施の第七形態では、前述の圧電基板8上に縦結合共振子型弹性表面波フィルタ2901と、縦結合共振子型弹性表面波フィルタ2901に直列接続された、各弹性表面波共振子2902、2903が、A1電極により形成されている。実施の第七形態の構成は、基本的には実施の第三形態の図29と同じ構成である。

【0187】

実施の第七形態の特徴は、電極指2919、2920のdutuが、0.40とされている点である。また、実施の第七形態ではシグナルライン2912と平衡信号端子2910の間に、アースに接続されたシールドライン2921が挿入されている。このようにシグナル電極同士が隣り合う箇所に、アースに接続されたシールドラインを挿入することで、シグナル電極間の橋絡容量が低減され、さらに平衡信号端子間の平衡度が改善された、弹性表面波装置が得られる。

【0188】

以下に、本実施の第七形態の作用・効果について説明する。図56に実施の第七形態の構成での、周波数に対する平衡信号端子間の振幅平衡度、図57に位相平衡度を示す。比較として図82に示す、第二比較例の構成での平衡信号端子間の振幅平衡度、位相平衡度も図56及び図57に合わせて示す。図82の第二比較例の構成は実施の第七形態に対して、IDT2905のIDT2904、2906に隣り合っている電極指のdutuを変えていない以外は、全く同じ構成である。PCS受信用フィルタにおける通過帯域の周波数範囲は1980MHz～1990MHzである。

【0189】

この範囲での平衡信号端子間の位相平衡度の偏差は実施の第七形態と第二比較例でほとんど変わっていないが、平衡信号端子間の振幅平衡度は、第二比較例では-0.5dB～+2.8dB（偏差2.8dB）であるのに対し、実施の第七形態では-0.6dB～+2.0dB（偏差2.6dB）と、約0.2dB振幅平衡度が改善している。

【0190】

さらに第二比較例では、平衡信号端子間の振幅平衡度および位相平衡度が+側か-側のどちらか一方に大きく外れているが、実施の第七形態では+方向と-方向のずれの差が、小さくなっている。実施の第七形態のように+方向と-方向のずれの差が小さい方が、+側か-側のどちらか一方に大きく外れているよりも同相信号のノイズレベルが小さくなるというメリットがあり、実施の第七形態の方が、この点でも優れている。

【0191】

実施の第七形態の効果が得られた理由は、IDT2905の各IDT2904、2906に隣り合っている電極指のdutuを、他の電極指のdutuより小さくすることで、各平衡信号端子2910、2911につながっている電極指の総容量や、電気信号と弹性表面波との間の変換効率を是正したことによる効果である。

【0192】

この電極指の総容量等の異なりは、特に2つのIDTが隣り合っている箇所で大きいので、実施の第七形態のようにこの部分の電極指のdutuを調整することで、最も大きな効果が得られる。さらに効果を得るためにには、図58のように、2つのIDTが隣り合っている箇所に近い数本の電極指のdutuを調整すればよい。

【0193】

次に、実施の第七形態における別の構成として、図59のようにIDT2904aとIDT2906aとの、IDT2905bと隣り合っている電極指（図59の3001と30

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02) のdu七<sub>0</sub>を、他の電極指のdu七<sub>0</sub>よりも小さくした場合の、周波数に対する平衡信号端子間の振幅平衡度を図60に、位相平衡度を図61に示す。このとき電極指3001と電極指3002のdu七<sub>0</sub>は0.40としている。

【0194】

比較として、図82の第二比較例の構成での平衡信号端子間の振幅平衡度、位相平衡度も図60及び図61に合わせて示す。この範囲での平衡信号端子間の位相平衡度の偏差は、実施の第七形態の変形例と第二比較例とほとんど変わっていないが、平衡信号端子間の振幅平衡度は、第二比較例では-0.5dB～+2.8dB(偏差2.8dB)であるのに対し、実施の第七形態の変形例では-0.5dB～+2.0dB(偏差2.5dB)と、約0.8dB振幅平衡度が改善している。

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【0195】

このように、図59のように不平衡信号端子に接続されているIDTの電極指のdu七<sub>0</sub>を調整することでも、本発明の効果は得られる。もちろんこれに加えて、IDT2905bにdu七<sub>0</sub>の調整を加えても、本発明の効果は得られる。

【0196】

以上、説明したように実施の第七形態では、1つの縦結合共振子型弹性表面波フィルタにおける1つのIDTの両極となるくし歯状電極にそれぞれ平衡信号端子が接続され、アースに接地された電気的中性点を有さない構成において、IDTの一部、特に2つのIDTが隣り合っている箇所をdu七<sub>0</sub>重み付けすることで、従来の弹性表面波装置よりも平衡信号端子間の振幅平衡度を改善した、弹性表面波装置が得られる。

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【0197】

(実施の第八形態)

本発明に係る実施の第八形態について、図62乃至図64に基づいて説明する。実施の第八形態の構成は、実施の第七形態のようにIDT2905のIDT2904、IDT2906と隣り合っている電極指のみのdu七<sub>0</sub>を0.40とするだけではなく、実施の第八形態では、平衡信号端子2910に接続されているIDT2905の電極指のdu七<sub>0</sub>をすべて、他の電極指と変えて、例えば、より小さく、0.40としている。その他の構成は、すべて実施の第七形態の構成と同じである。

【0198】

以下に、本実施の第八形態の作用・効果について説明する。図63に、実施の第八形態の構成での、周波数に対する平衡信号端子間の振幅平衡度、図64に位相平衡度を示す。比較として、図82に示す第二比較例の構成での、平衡信号端子間の振幅平衡度、位相平衡度も図63及び図64に合わせて示す。PCS受信用フィルタの通過帯域の周波数範囲では、平衡信号端子間の位相平衡度は第二比較例よりわずかに悪化しているが、平衡信号端子間の振幅平衡度は、第二比較例より約0.5dB改善している。

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【0199】

さらに第二比較例では、平衡信号端子間の振幅平衡度および位相平衡度が+側が-側のどちらか一方に大きく外れているが、実施の第八形態では+方向と-方向のずれの差が、小さくなっている。実施の第八形態のように+方向と-方向のずれの差が小さい方が、+側が-側のどちらか一方に大きく外れているよりも同相信号のノイズレベルが小さくなるというメリットがあり、実施の第八形態の方が、この点でも優れている。

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【0200】

以上、説明したように実施の第八形態では、1つの縦結合共振子型弹性表面波フィルタの1つのIDTの両極のくし歯状電極にそれぞれ平衡信号端子が接続され、アースに接地された電気的中性点を有さない構成において、平衡信号端子の一方に接続されている電極指をすべてdu七<sub>0</sub>重み付けすることで、従来の弹性表面波装置よりも平衡信号端子間の振幅平衡度を改善した、弹性表面波装置が得られる。

【0201】

図62のように、平衡信号端子2910に接続されているIDT2905cの電極指のdu七<sub>0</sub>をすべて調整すると、平衡信号端子間の振幅平衡度を更に改善することができるが

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、位相平衡度は逆に悪化してしまう。しかし、図55や図58のようにすべての電極指は調整せずに必要な本数だけ調整したり、あるいは電極指毎にdu+の調整量を異ならせたりすることで、平衡信号端子間の位相平衡度を悪化させずに、振幅平衡度を改善することは可能である。

### 【0202】

#### (実施の第九形態)

本発明に係る実施の第九形態について、図65に基づいて説明する。実施の第九形態は基本的には実施の第七形態と同じ構成であるが、IDT2904とIDT2905dとが互いに隣り合う箇所においてIDT2905dの電極指8008のdu+を小さくし、さらにIDT2905dとIDT2906bとが隣り合う箇所においてIDT2906bの最外のシグナル電極指が間引かれ、その間引かれた位置にアースに接続されたダミー電極3004が設置された、間引き重み付けされている。

### 【0203】

次に、本実施の第九形態の作用・効果について説明する。このように1つの縦結合共振子型弾性表面波フィルタ内に2種類の重み付け方法を混在したりマリに数種類の重み付け方法を混在させたりすることで、平衡信号端子間の平衡度の調整自由度が向上し、所望の平衡信号端子間の平衡度を有した、平衡信号端子を有する弾性表面波装置が得られる。

### 【0204】

以上の実施の各形態では、圧電基板として、40±5°Ycut X伝搬LiTaO<sub>3</sub>基板を用いたが、効果が得られる原理からもわかる通り、本発明はこの基板に限らず、64～72°Ycut X伝搬LiNbO<sub>3</sub>、41°Ycut X伝搬LiNbO<sub>3</sub>などの基板でも同様な効果が得られる。

### 【0205】

また、3以上のIDTを備える弾性表面波フィルタを2つ用いて、平衡-不平衡変換機能を有する弾性表面波装置においては、弾性表面波フィルタの電極指に対して、弾性表面波の励振が強くなる方向に重み付けすることが好みしい。これにより、通過帯域幅が狭くなることを抑制しながら、通過帯域内の振幅平衡度を改善できる。

### 【0206】

このような弾性表面波の励振が強くなる方向の重み付けの例としては、一方の弾性表面波装置（第1の弾性表面波装置）には重み付けせず、他方の弾性表面波装置（第2の弾性表面波装置）の中央のIDTの最外電極指（より望ましくはシグナル電極指）の双方に対して、間引き重み付け、交叉重み付け（ダミー電極の形成も含む）、または直列重み付け（最も好みしい）を施すことが挙げられる。

### 【0207】

さらに、上記の実施の各形態では、それぞれ種々な重み付けについて説明したが、それらは互いに独立した作用・効果を備えており、それらを二以上、どのように組み合わせて用いても、本願発明の効果を得ることができる。

### 【0208】

本発明に係る、上記の実施の各形態に記載の弾性表面波装置を搭載した通信装置について、図66に基づいて説明すると以下の通りである。図66に示すように、実施の第一乃至第九の何れかに記載の弾性表面波装置を搭載した通信機3100は、受信を行ラレシーバ側（R×側）として、アンテナ3101、アンテナ共用部／RFTOPフィルタ3102、アンプ3103、R×段間フィルタ3104、ミキサ3105、1stIFフィルタ3106、ミキサ3107、2ndIFフィルタ3108、1st+2ndローカルシンセサイザ3111、TCXO（Temperature Compensated crystal oscillator）3112、デバイダ3118、ローカルフィルタ3114を備えて構成されている。R×段間フィルタ3104からミキサ3105へは、図66にて二本線で示したように、平衡信号端子間の平衡度を確保するために、各平衡信号にて送信することが好みしい。

### 【0209】

また、上記通信装置 8100 は、送信を行なうトランシーバ側 (T×側) として、上記アンテナ 8101 および上記アンテナ共用部／RFTOP フィルタ 8102 を共用するとともに、T×IF フィルタ 8121、ミキサ 8122、T×段間フィルタ 8123、アンプ 8124、カプラ 8125、アイソレータ 8126、APC (Automatic Power Control Counter) 8127 を備えて構成されている。

【0210】

そして、上記の R×段間フィルタ 8104 には、上述した実施の第一乃至第九形態の何れかに記載の弹性表面波装置が好適に利用できる。

【0211】

よって、上記通信装置 8100 は、用いた弹性表面波装置が小型化を図りながら、伝送特性に優れていますので、小型化、特に GHz 帯域以上において小型化を図りながら、伝送特性（通信性能）に優れたものとなっています。

【0212】

【発明の効果】

本発明の弹性表面波装置は、以上のように、圧電基板上に、複数の電極指を有する入力用 IDT と、複数の電極指を有する出力用 IDT とが、縦結合共振子型を形成するように弹性表面波の伝搬方向に沿って設けられ、前記入力用 IDT 及び出力用 IDT の一方は、平衡用であり、平衡側の少なくとも一方の各電極指の最外電極指と異なる内側電極指に、重み付けされた重み付け電極指を有している構成である。

【0213】

それゆえ、上記構成では、平衡側の少なくとも一方の各電極指の最外電極指と異なる内側電極指に、重み付けされた重み付け電極指を有していることにより、平衡側の平衡度を改善できるという効果を奏する。

【0214】

本発明の他の弹性表面波装置は、以上のように、圧電基板上に弹性表面波の伝搬方向に沿って形成された少なくとも 2 つの IDT を有する弹性表面波フィルタを少なくとも 1 つと、上記弹性表面波フィルタのための入力信号端子及び出力信号端子とを備えている弹性表面波装置であって、入力信号端子及び出力信号端子の少なくとも一方は平衡信号端子に接続されており、かつ、上記 IDT における、最外電極指以外の電極指が、電極指の交叉幅を他の電極指と異なる交又幅重み付けされている構成である。

【0215】

それゆえ、上記構成は、上記 IDT における、最外電極指以外の電極指が、電極指の交叉幅を他の電極指と異なる交又幅重み付けされていることにより、例えば、各平衡端子間での平衡度（バランス性）を改善できるという効果を奏する。

【0216】

本発明のさらに他の弹性表面波装置は、以上のように、互いに隣り合う IDT の少なくとも一方において、上記 IDT が互いに隣り合う箇所の最外電極指の du7 オンを他の電極指と異なる du7 オン重み付けが施されており、かつ、異なる互いに隣り合う IDT の少なくとも一方において、上記 IDT が互いに隣り合う箇所の最外電極指に対して間引き重み付けされていると共に、上記間引き重み付けされた箇所には、上記間引き重み付けされた電極指が接続されたバスバーと対向する対向バスバーに接続されたタミー電極が設けられている構成である。

【0217】

それゆえ、上記構成は、du7 オン重み付け、間引き重み付けを施し、かつ、タミー電極を設けたことによって、各平衡端子間での平衡度（バランス性）を改善できるという効果を奏する。

【0218】

本発明の通信装置は、以上のように、上記弹性表面波装置を用いたことを特徴としている。

【0219】

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それゆえ、上記構成は、小型化、特にGH区帯域以上において小型化を図りながら、伝送特性（通信性能）に優れるという効果を奏する。

【図面の簡単な説明】

【図1】本発明の実施の第一形態に係る弹性表面波装置の要部構成図である。

【図2】第一比較例の弹性表面波装置の要部構成を示す説明図である。

【図3】上記実施の第一形態の一変形例に係る弹性表面波装置の要部構成図である。

【図4】上記実施の第一形態の弹性表面波装置での重み付け領域を説明するための要部構成図である。

【図5】上記弹性表面波装置の振幅平衡度（振幅バランス）を示すグラフである。

【図6】上記弹性表面波装置の位相平衡度（位相バランス）を示すグラフである。

【図7】上記第一比較例の弹性表面波装置の振幅平衡度（振幅バランス）を示すグラフである。

【図8】上記第一比較例の弹性表面波装置の位相平衡度（位相バランス）を示すグラフである。

【図9】上記実施の第一形態における他の変形例に係る弹性表面波装置の要部構成図である。

【図10】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図11】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図12】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図13】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図14】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図15】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図16】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図17】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図18】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図19】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図20】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図21】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図22】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図23】上記実施の第一形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図24】本発明の実施の第二形態に係る弹性表面波装置の要部構成図である。

【図25】上記弹性表面波装置の振幅平衡度（振幅バランス）を示すグラフである。

【図26】上記弹性表面波装置の位相バランスを示すグラフである。

【図27】上記実施の第一形態に係る弹性表面波装置の伝送特性を示すグラフである。

【図28】上記実施の第二形態に係る弹性表面波装置の伝送特性を示すグラフである。

【図29】本発明の実施の第三形態に係る弹性表面波装置の要部構成図である。

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【図 8 0】上記実施の第三形態と、第二比較例とに係る弹性表面波装置の振幅平衡度（振幅バランス）を示すグラフである。

【図 8 1】上記実施の第三形態と、第二比較例とに係る弹性表面波装置の位相バランスを示すグラフである。

【図 8 2】上記第二比較例に係る弹性表面波装置の要部構成図である。

【図 8 3】本発明の実施の第四形態に係る弹性表面波装置の要部構成図である。

【図 8 4】上記実施の第四形態と、第二従来例とに係る弹性表面波装置の振幅平衡度（振幅バランス）を示すグラフである。

【図 8 5】上記第二従来例におけるバランス劣化を示すための要部構成図である。

【図 8 6】上記実施の第四形態におけるバランス改善を示すための要部構成図である。

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【図 8 7】上記実施の第四形態における一変形例の弹性表面波装置の要部構成図である。

【図 8 8】上記実施の第四形態の一変形例におけるバランス改善を示すための要部構成図である。

【図 8 9】上記実施の第四形態における他の変形例である弹性表面波装置の要部構成図である。

【図 4 0】上記実施の第四形態における他の変形例におけるバランス改善を示すための要部構成図である。

【図 4 1】上記実施の第四形態におけるさらに他の変形例である弹性表面波装置の要部構成図である。

【図 4 2】本発明の実施の第五形態に係る弹性表面波装置の要部構成図である。

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【図 4 3】上記実施の第五形態と、第三比較例とに係る弹性表面波装置の振幅平衡度（振幅バランス）を示すグラフである。

【図 4 4】上記第三比較例に係る弹性表面波装置の要部構成図である。

【図 4 5】上記第三比較例におけるバランス劣化を示すための要部構成図である。

【図 4 6】上記実施の第五形態におけるバランス改善を示すための要部構成図である。

【図 4 7】本発明の実施の第六形態に係る弹性表面波装置の要部構成図である。

【図 4 8】上記実施の第六形態に係る弹性表面波装置の要部拡大構成図である。

【図 4 9】上記実施の第六形態と、第四比較例とに係る弹性表面波装置の振幅平衡度（振幅バランス）を示すグラフである。

【図 5 0】上記第四比較例に係る弹性表面波装置の要部構成図である。

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【図 5 1】上記実施の第六形態に係る弹性表面波装置における、交叉幅の変化に伴う振幅平衡度（振幅バランス）の変化を示すグラフである。

【図 5 2】上記実施の第六形態の一変形例に係る弹性表面波装置の要部構成図である。

【図 5 3】上記実施の第六形態における他の変形例に係る弹性表面波装置の要部構成図である。

【図 5 4】上記実施の第六形態におけるさらに他の変形例に係る弹性表面波装置の要部構成図である。

【図 5 5】本発明の実施の第七形態に係る弹性表面波装置の要部構成図である。

【図 5 6】上記実施の第七形態と、第二比較例とに係る弹性表面波装置の振幅平衡度（振幅バランス）を示すグラフである。

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【図 5 7】上記実施の第七形態と、第二比較例とに係る弹性表面波装置の位相バランスを示すグラフである。

【図 5 8】上記実施の第七形態の一変形例に係る弹性表面波装置の要部構成図である。

【図 5 9】上記実施の第七形態における他の変形例に係る弹性表面波装置の要部構成図である。

【図 6 0】上記実施の第七形態における他の変形例と、第二比較例とに係る弹性表面波装置の振幅平衡度（振幅バランス）を示すグラフである。

【図 6 1】上記実施の第七形態における他の変形例と、第二比較例とに係る弹性表面波装置の位相バランスを示すグラフである。

【図 6 2】本発明の実施の第八形態に係る弹性表面波装置の要部構成図である。

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【図 6 3】上記実施の第八形態と、第二比較例とに係る弹性表面波装置の振幅平衡度（振幅バランス）を示すグラフである。

【図 6 4】上記実施の第八形態と、第二比較例とに係る弹性表面波装置の位相バランスを示すグラフである。

【図 6 5】本発明の実施の第九形態に係る弹性表面波装置の要部構成図である。

【図 6 6】本発明の通信装置の要部プロック図である。

【図 6 7】第一従来例の弹性表面波装置の要部構成図である。

【図 6 8】第二従来例の弹性表面波装置の要部構成図である。

【図 6 9】従来における平衡信号端子間での挿入損失の違いを示すためのグラフである。

【図 7 0】上記従来における平衡信号端子間での挿入損失の違いを示すための、一方の弹性表面波装置の要部構成図である。 10

【図 7 1】上記従来における平衡信号端子間での挿入損失の違いを示すための、他方の弹性表面波装置の要部構成図である。

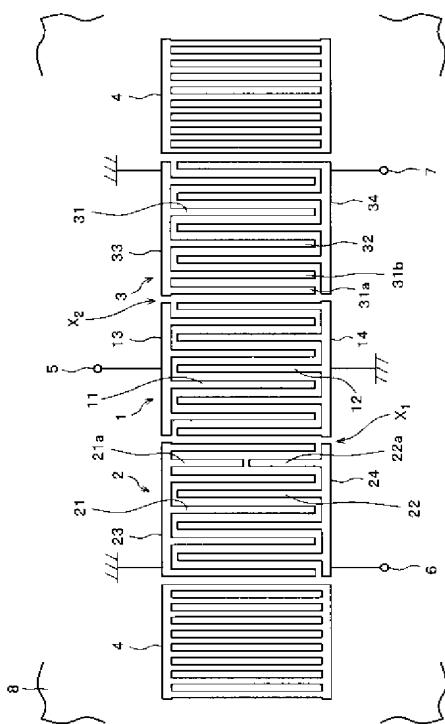
【図 7 2】弹性表面波装置における共振モードを説明するものであって、(a) は共振モードの周波数関係を示すグラフであり、(b) は共振モードの有効電流分布を示す、概略構成図及びそれに対応する電流分布のグラフである。

【図 7 3】第三従来例の弹性表面波装置の要部構成図である。

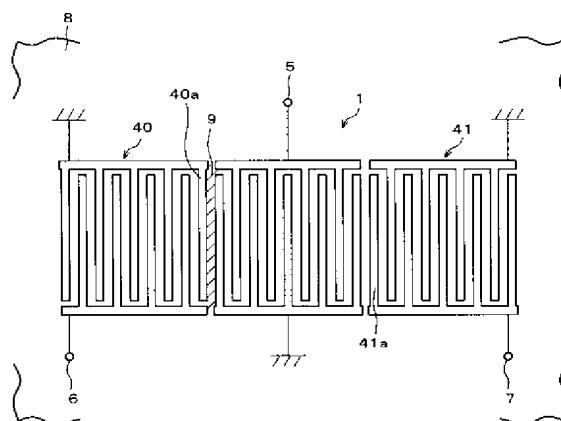
【符号の説明】

1	I D T (くし型電極部)
2	I D T (くし型電極部)
3	I D T (くし型電極部)
2 2	シグナル電極指 (内側電極指)
2 1 a	ダミー電極
2 2 a	交叉重み付け電極指 (重み付け電極指)
3 1 a	ダミー電極

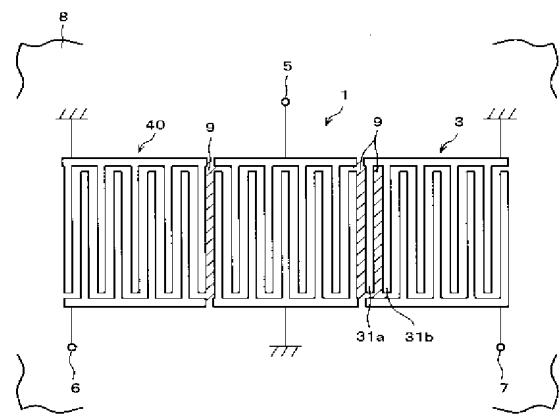
【図 1】



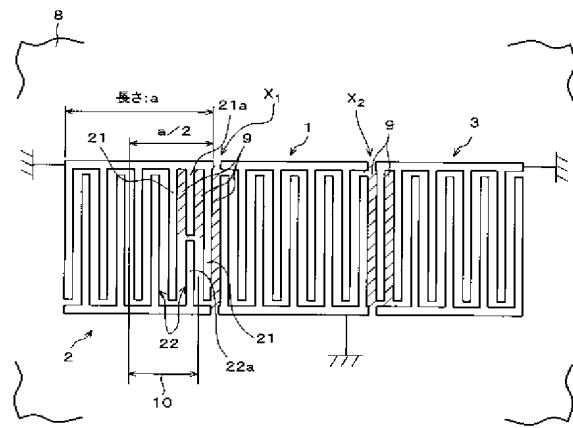
【図 2】



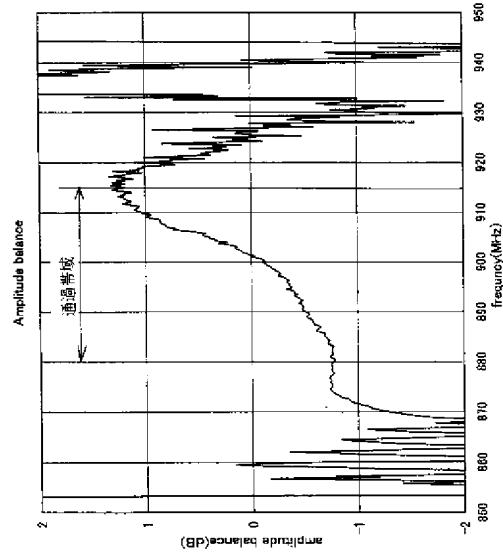
【図 8】



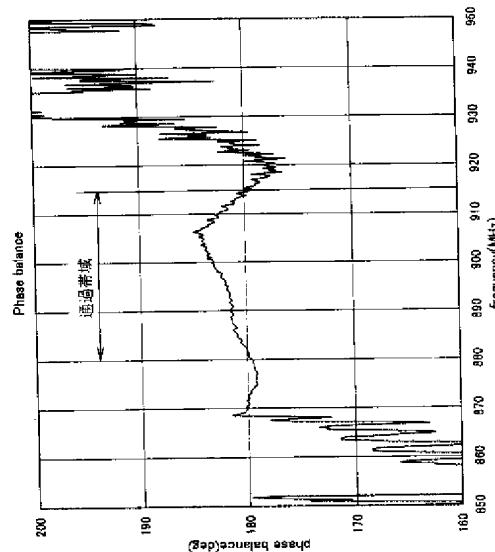
【図 4】



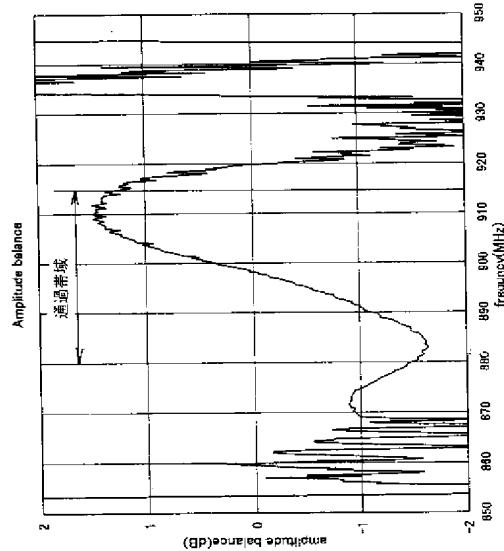
【図 5】



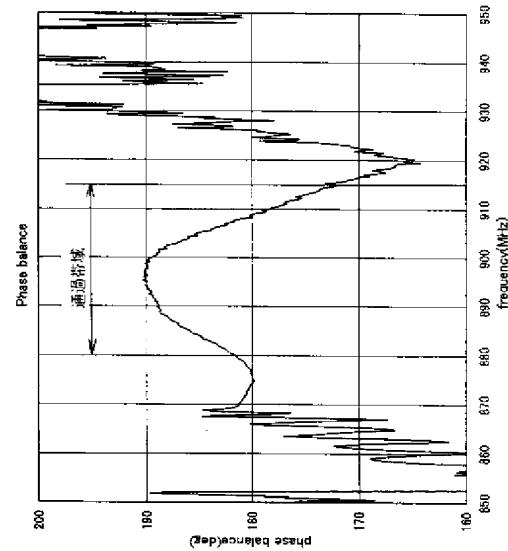
【図 6】



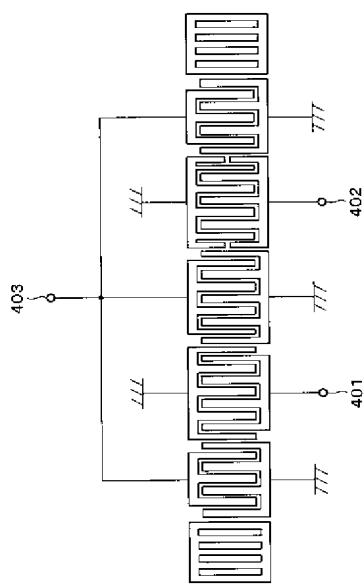
【図7】



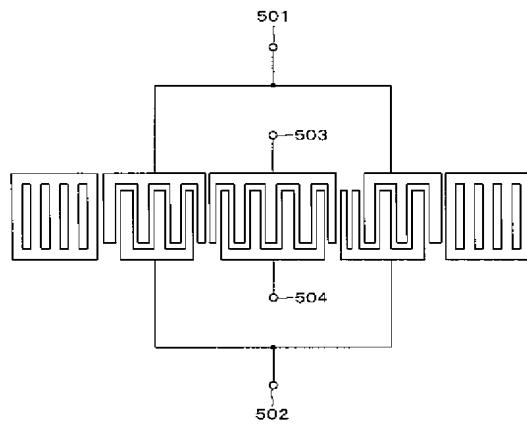
【図8】



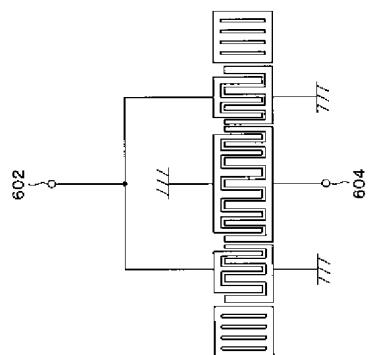
【図9】



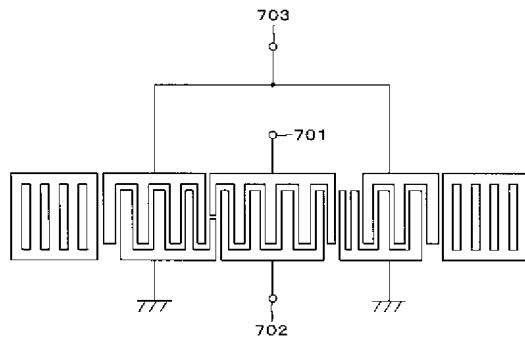
【図10】



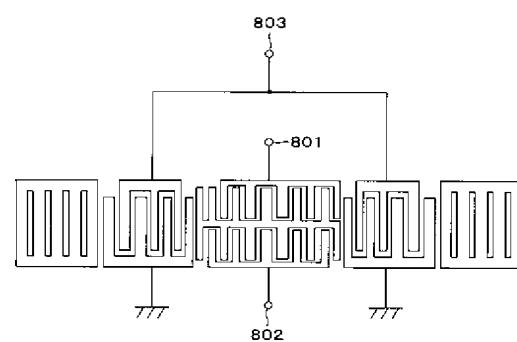
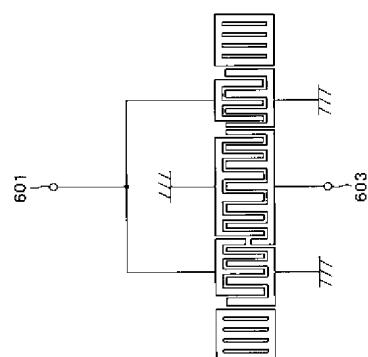
【図 1 1】



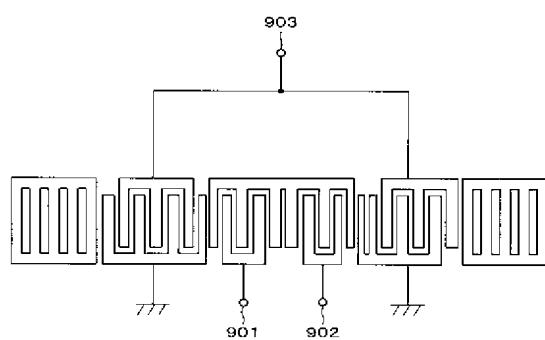
【図 1 2】



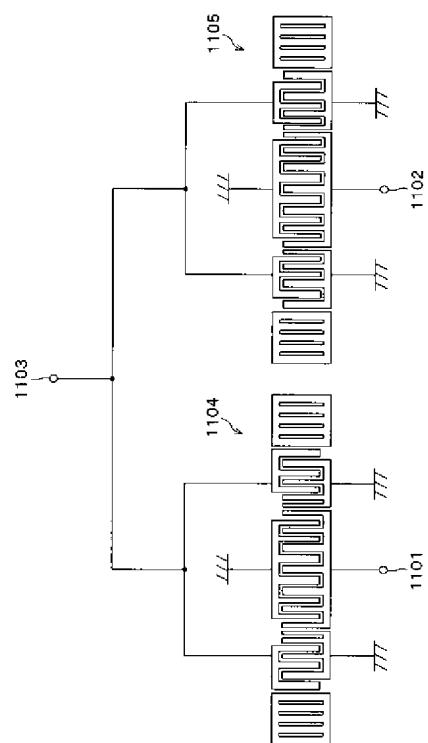
【図 1 3】



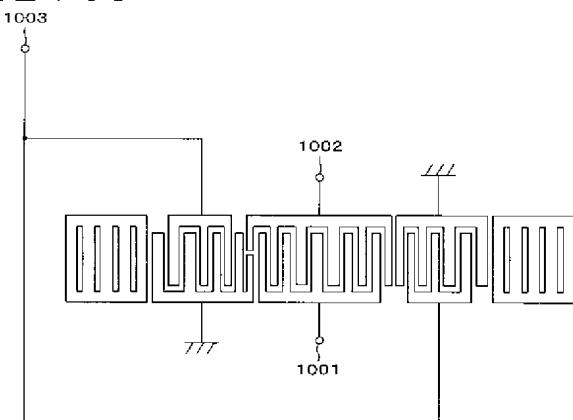
【図 1 4】



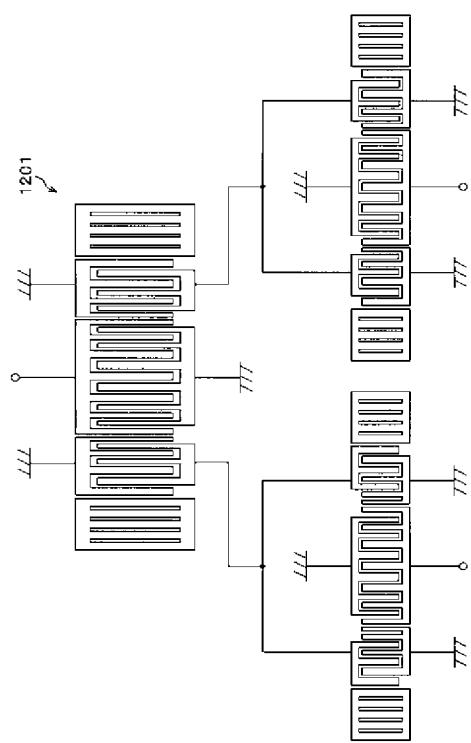
【図 1 6】



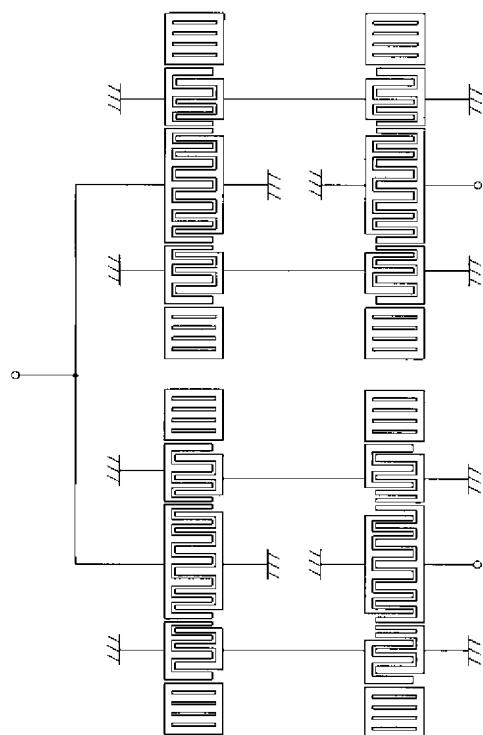
【図 1 5】



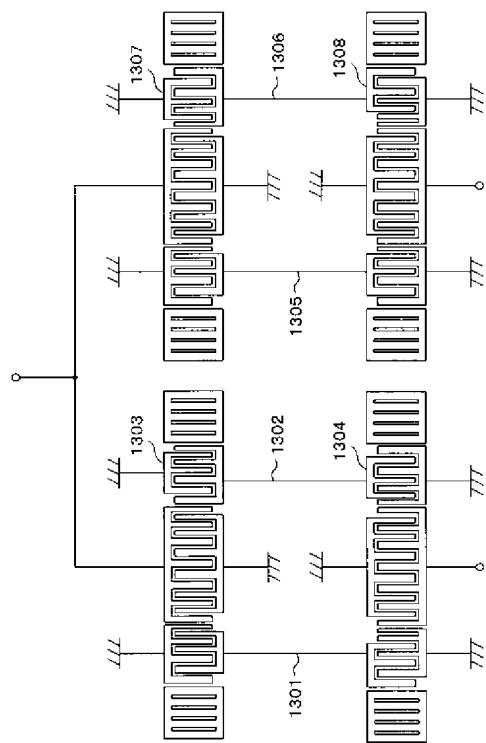
【図17】



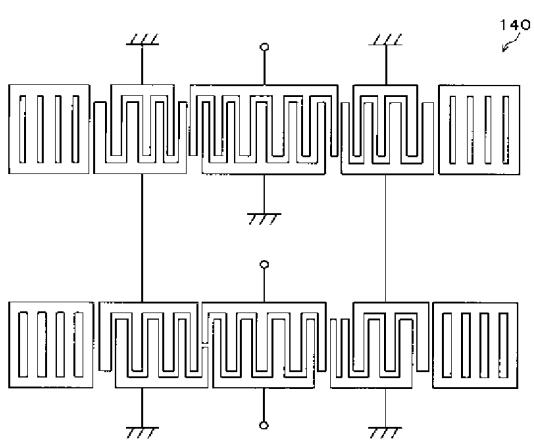
【図18】



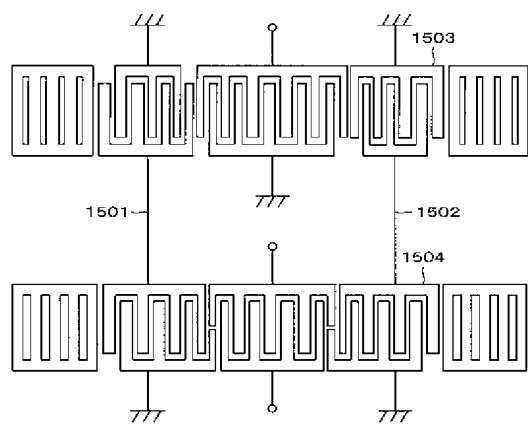
【図19】



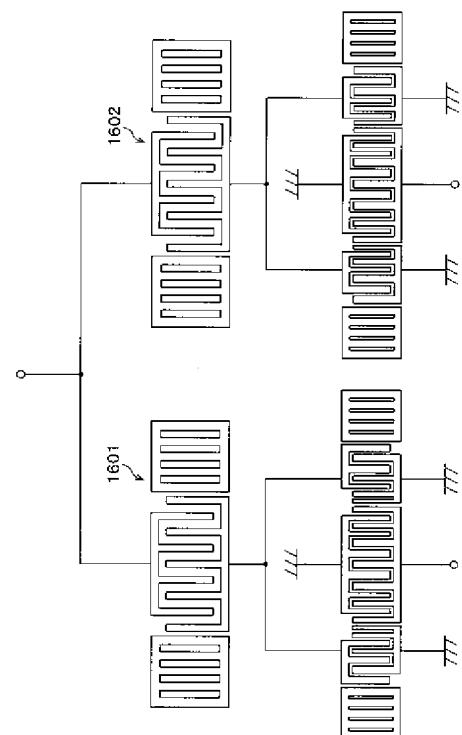
【図20】



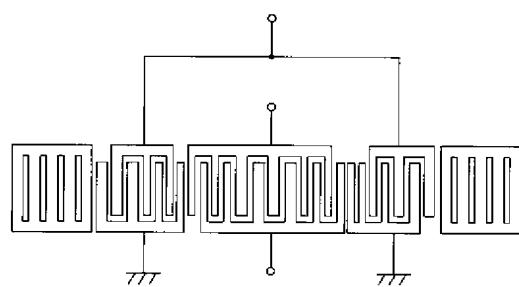
【図 2 1】



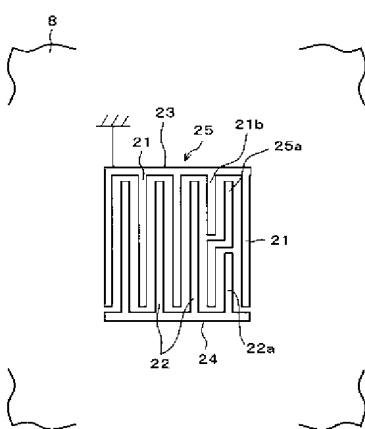
【図 2 3】



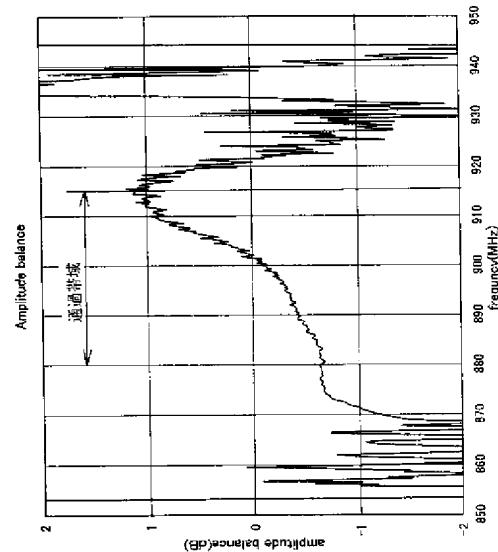
【図 2 2】



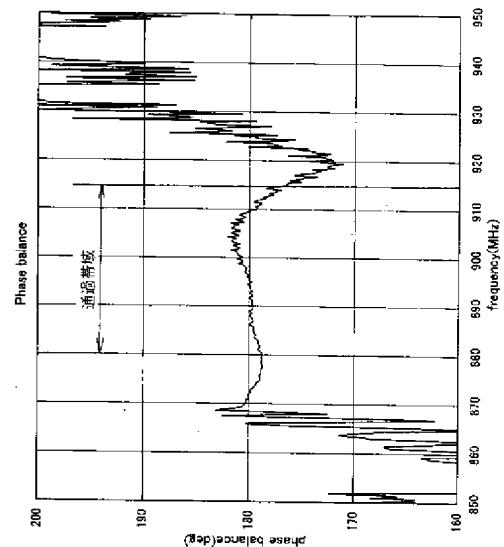
【図 2 4】



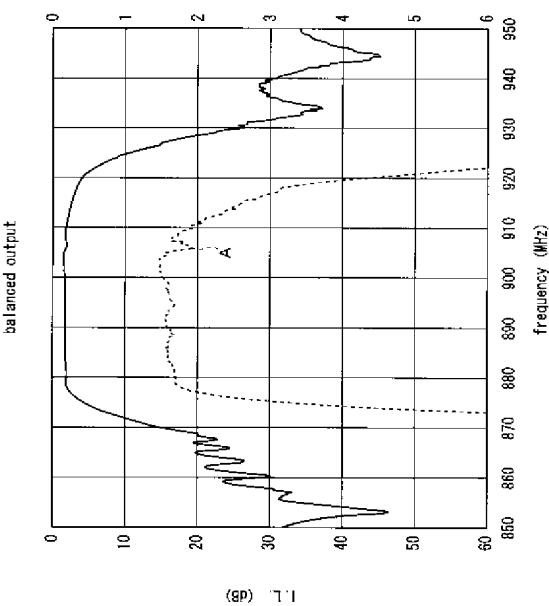
【図 2 5】



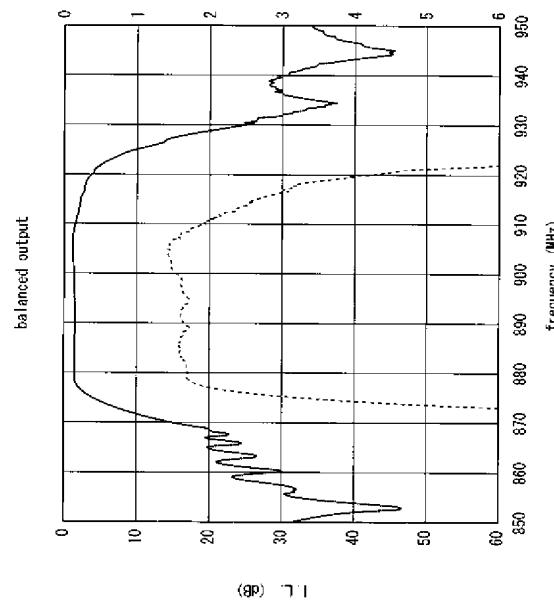
【図 2 6】



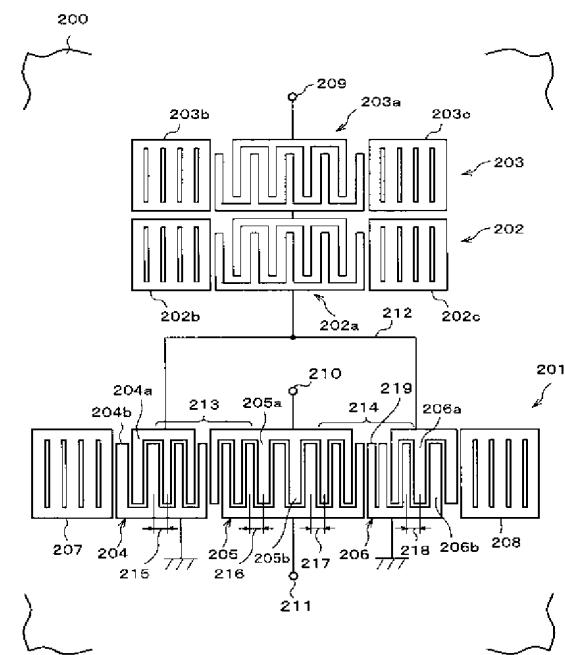
【図 2 7】



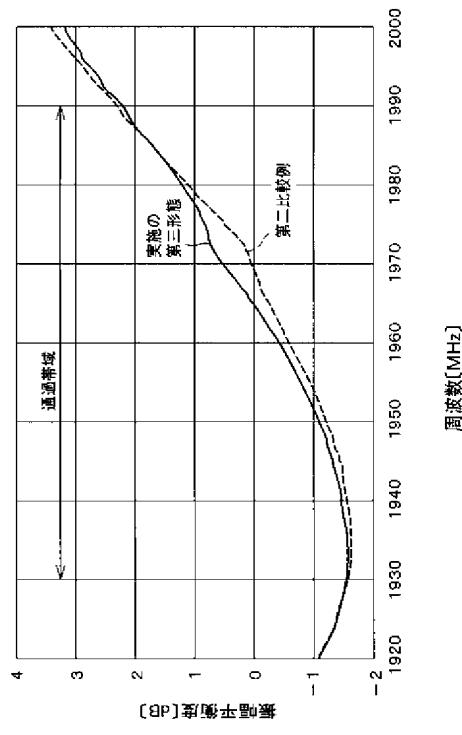
【図 2 8】



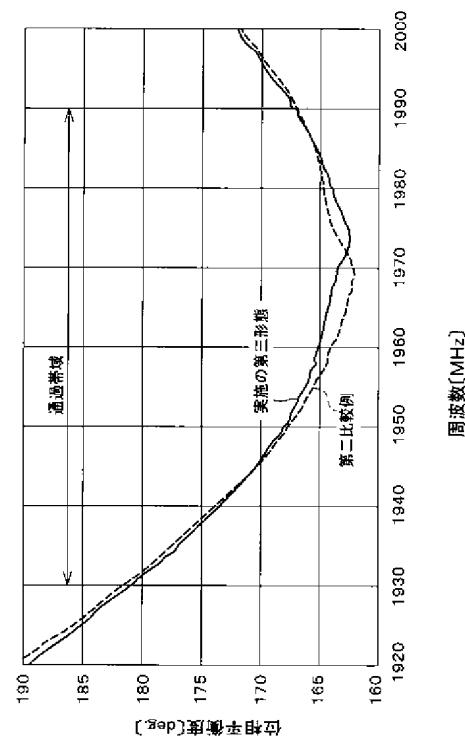
【図 2 9】



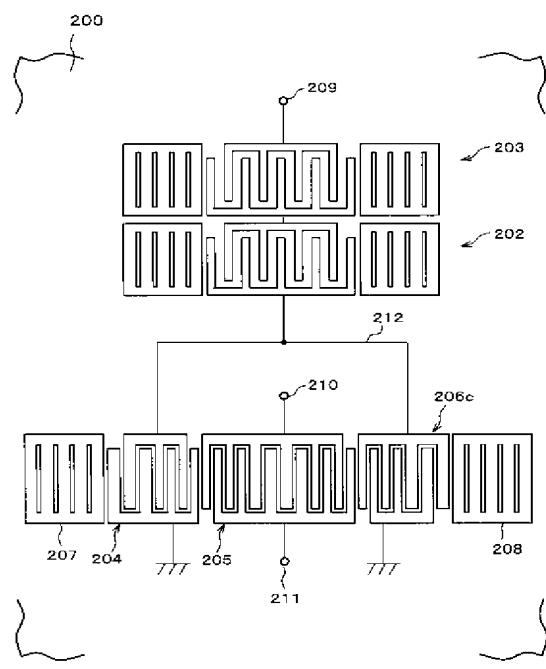
【図 8 0】



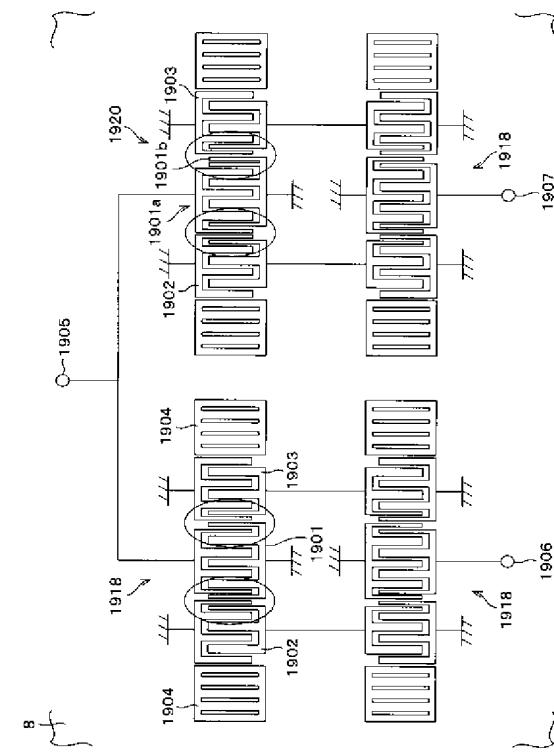
【図 8 1】



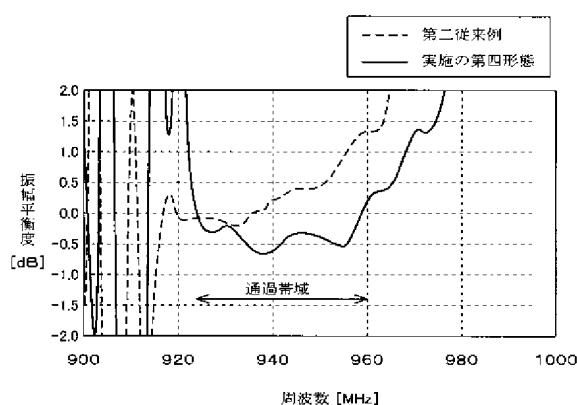
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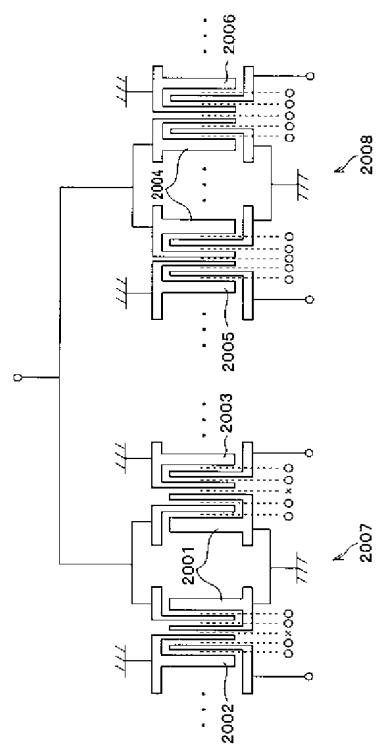
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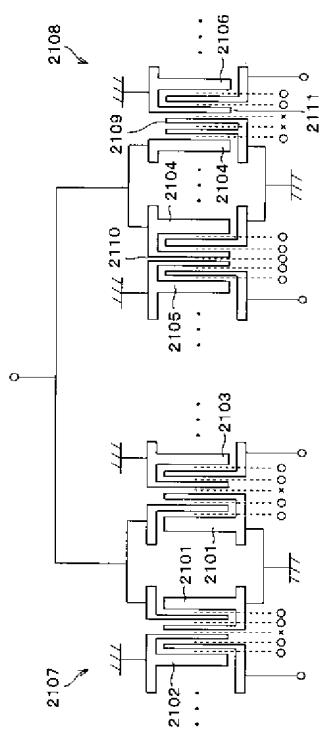
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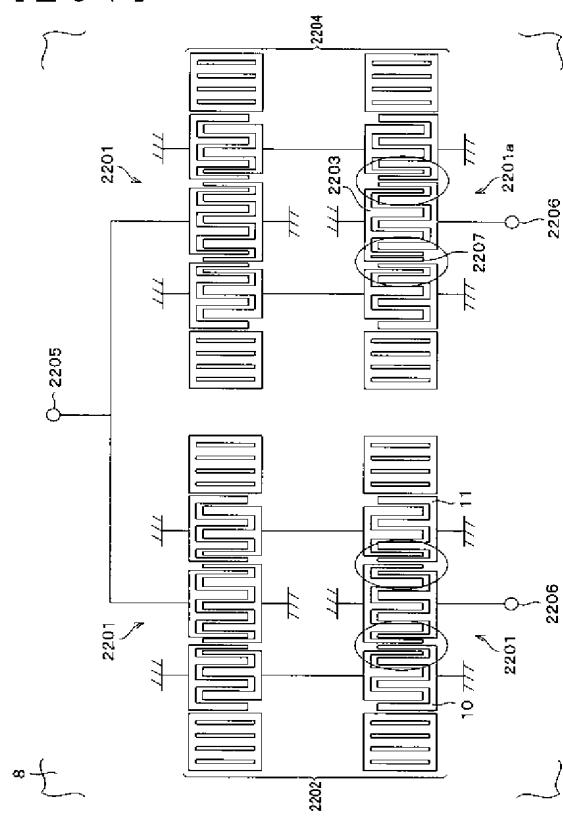
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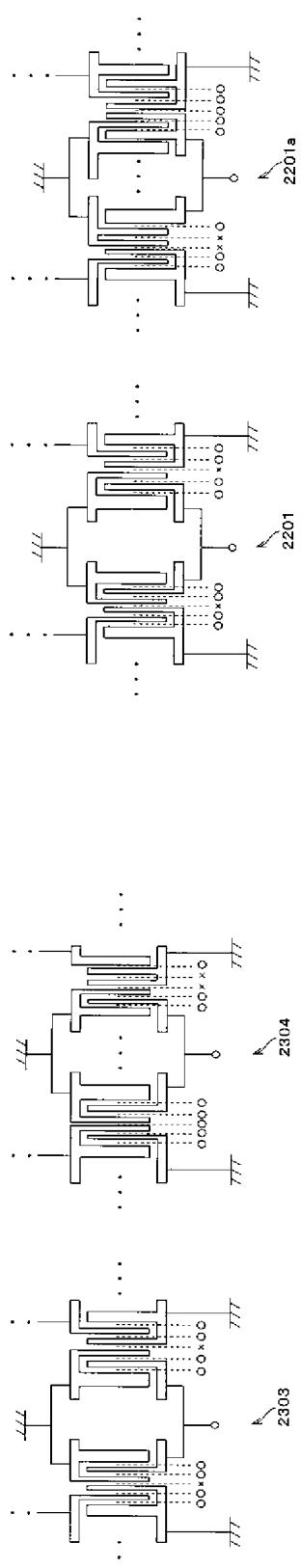
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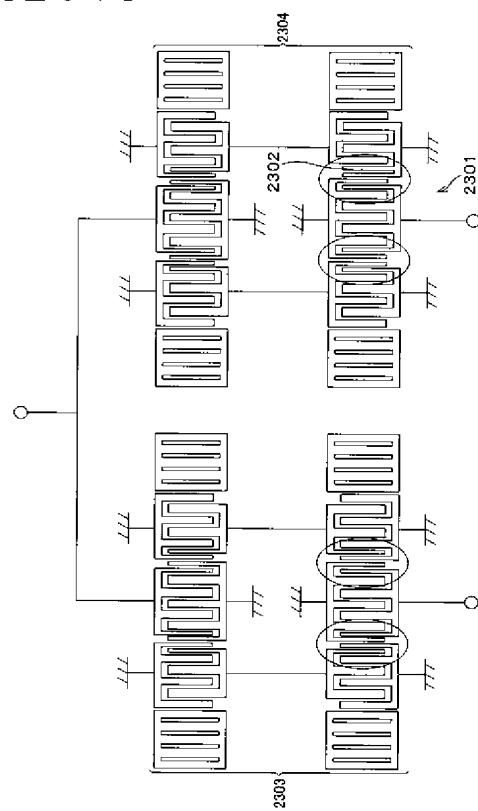
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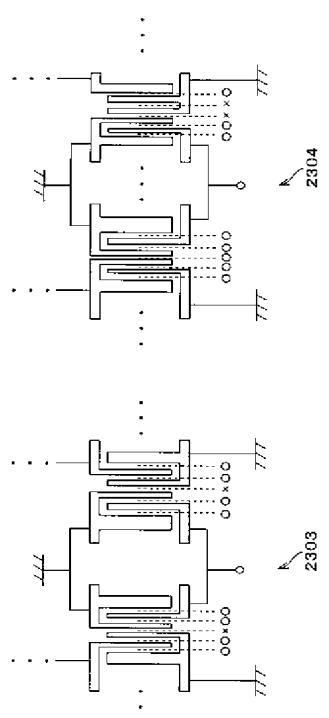
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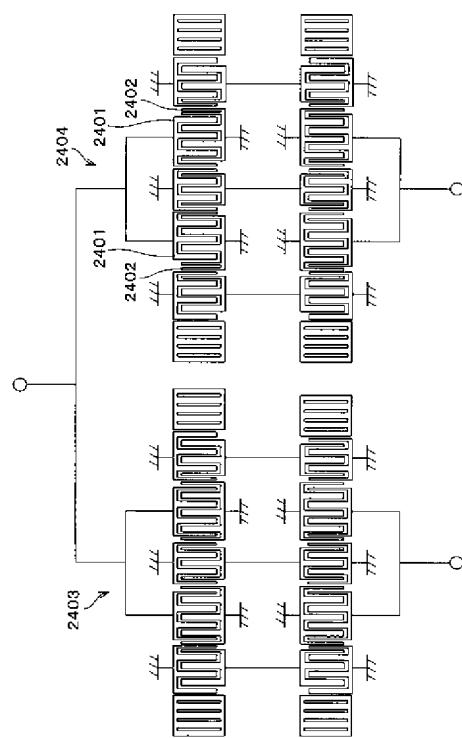
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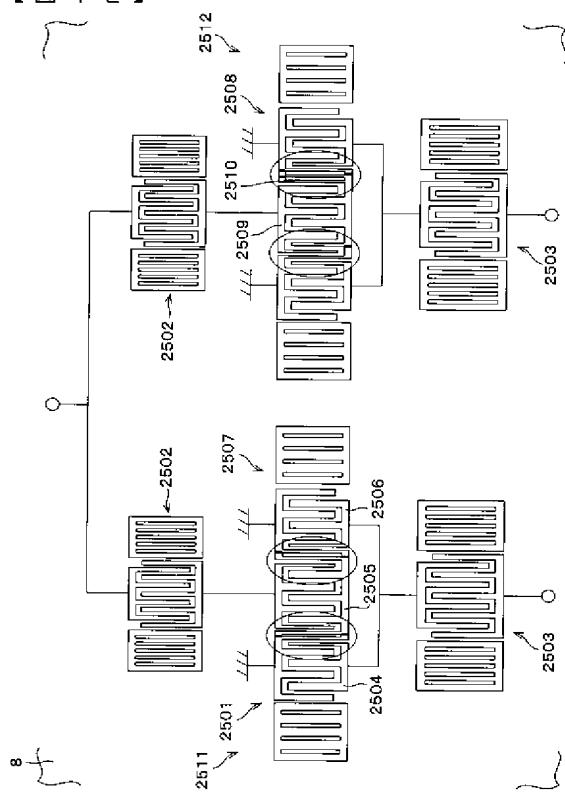
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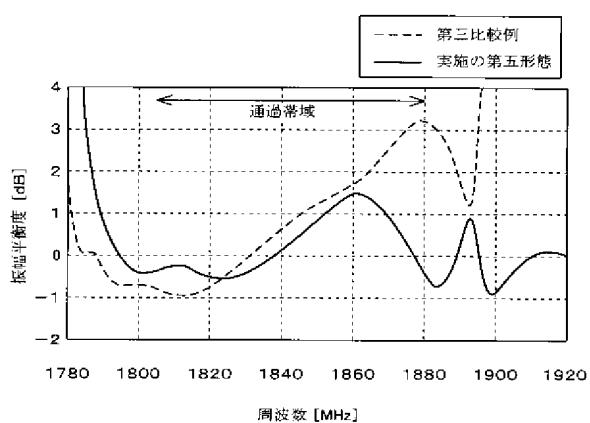
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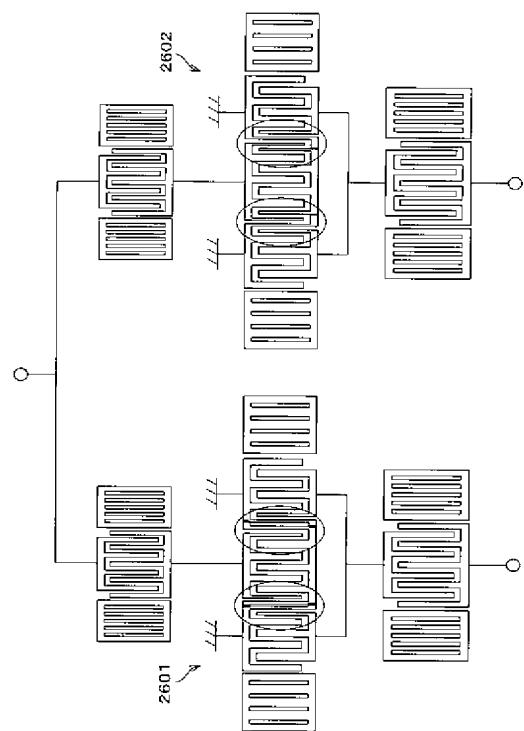
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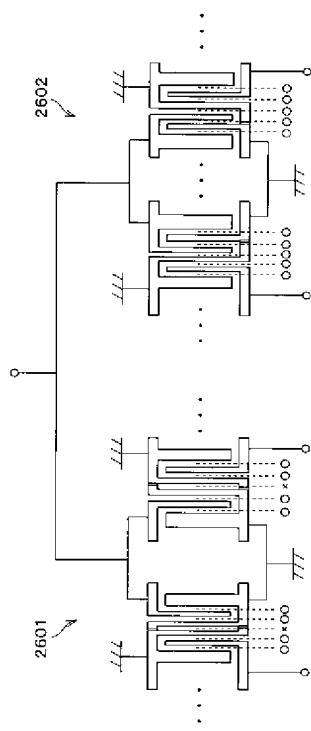
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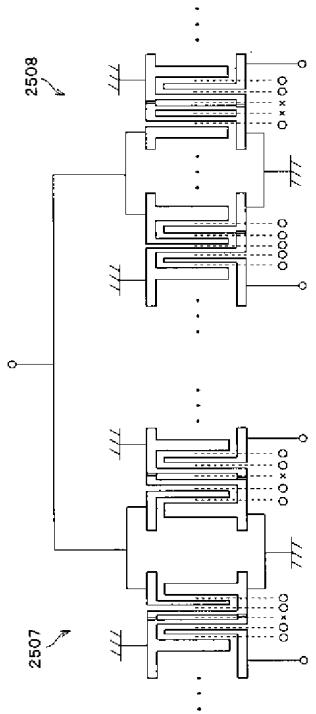
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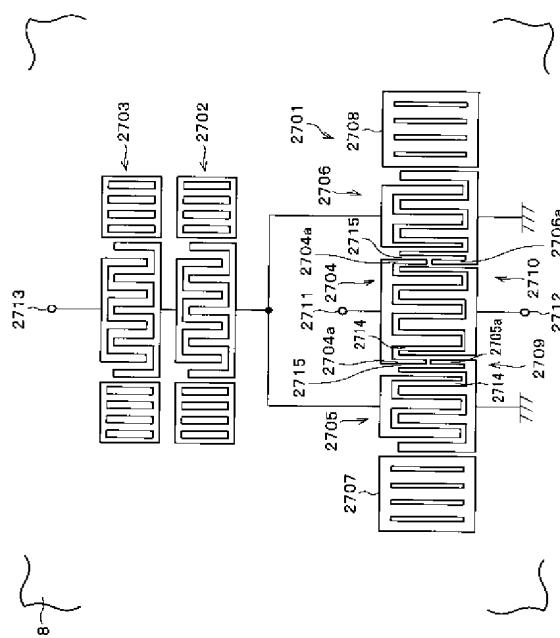
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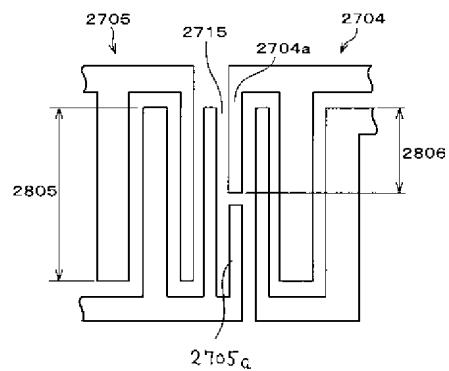
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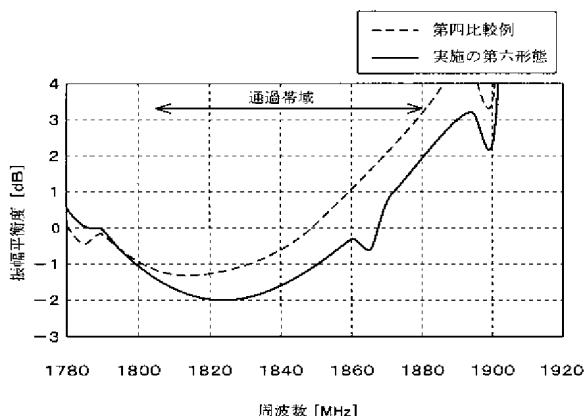
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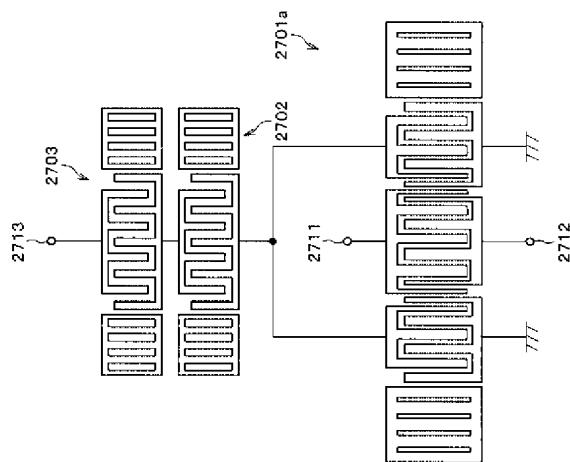
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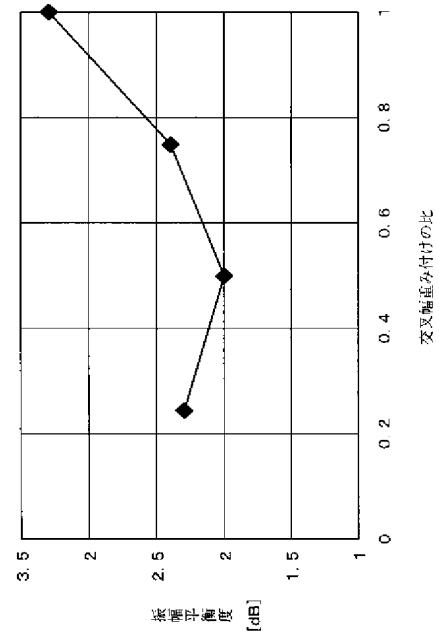
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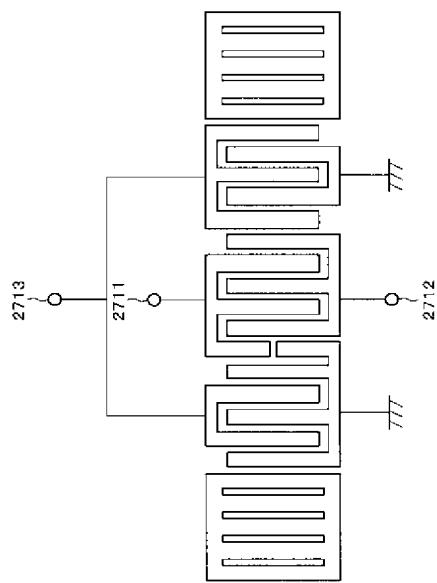
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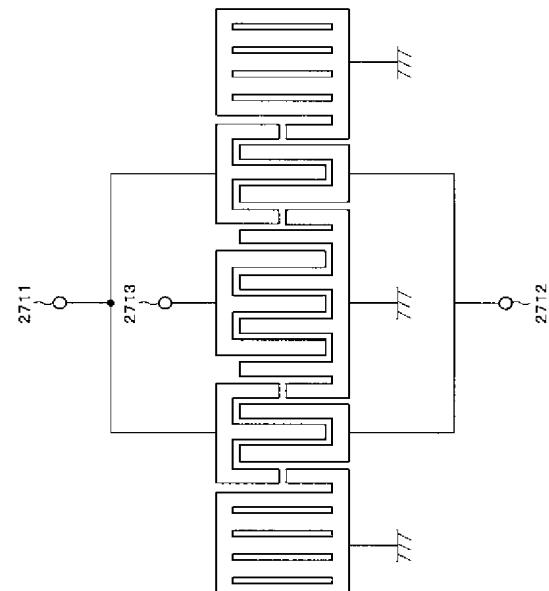
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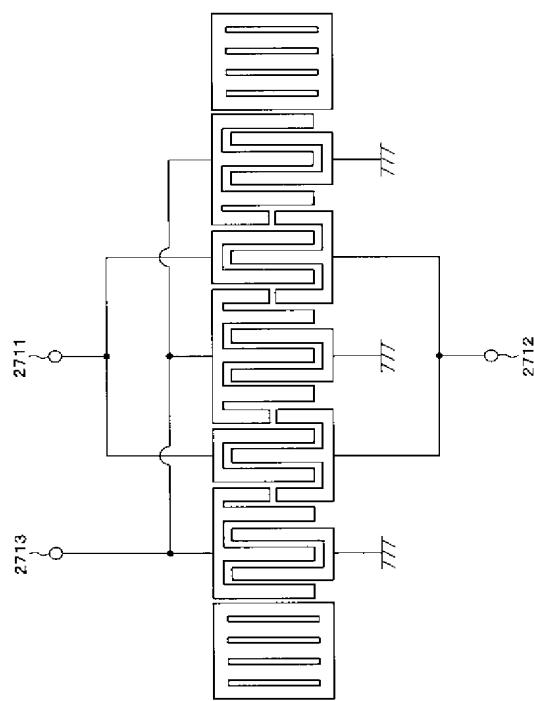
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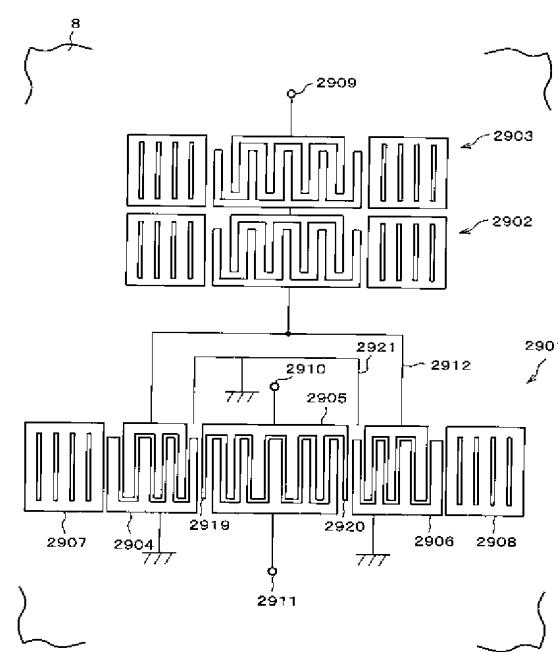
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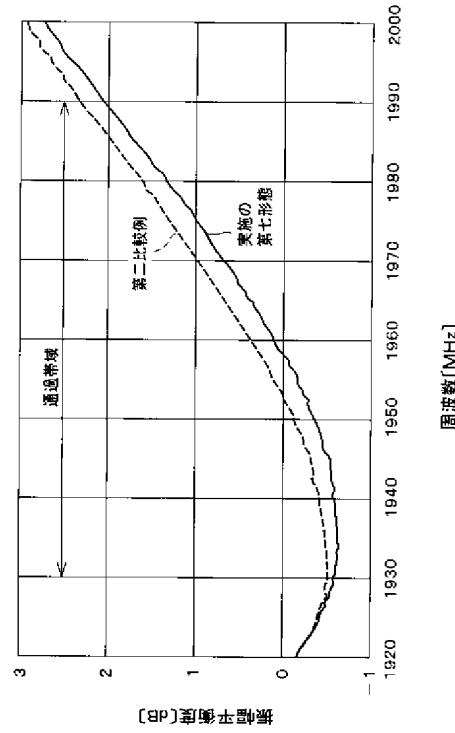
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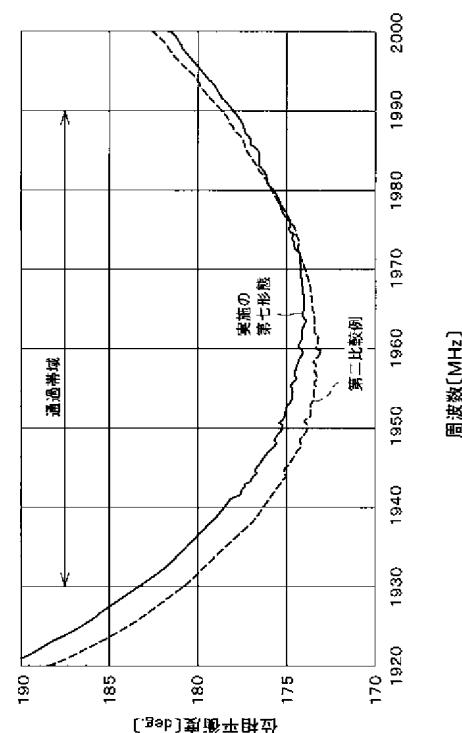
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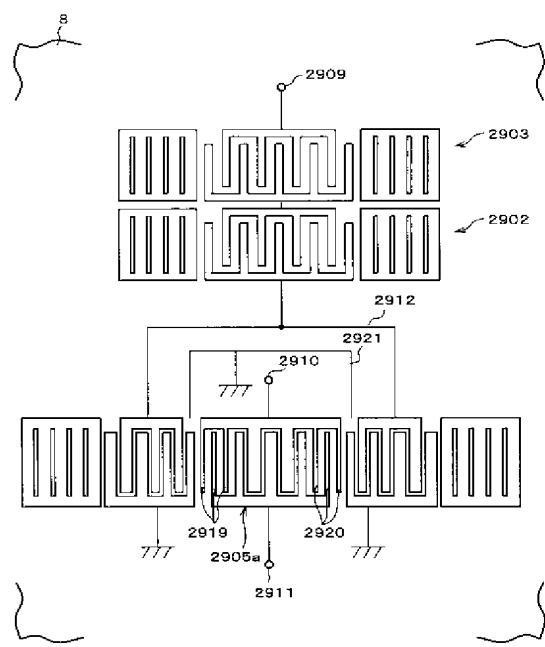
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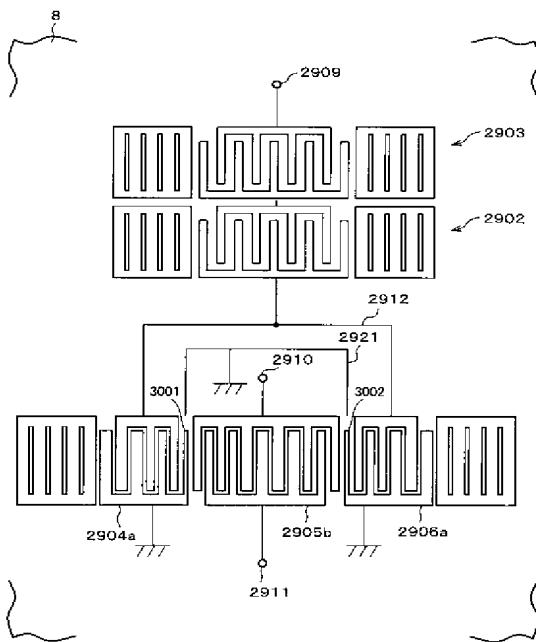
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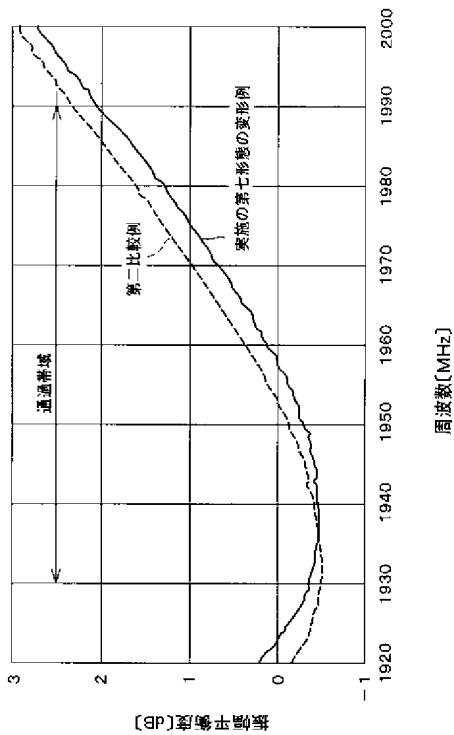
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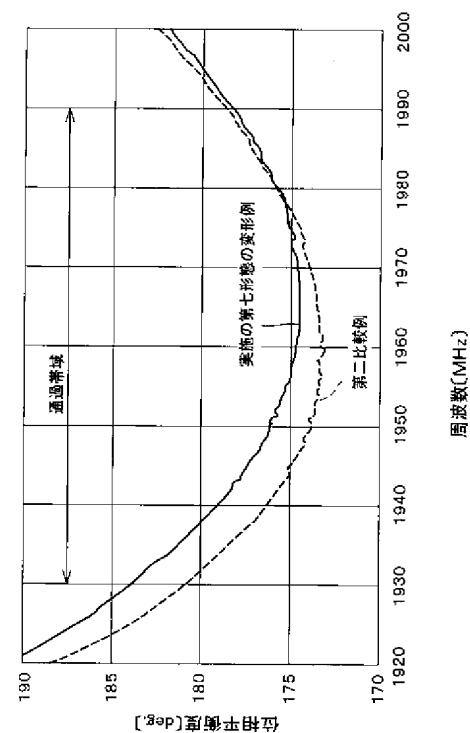
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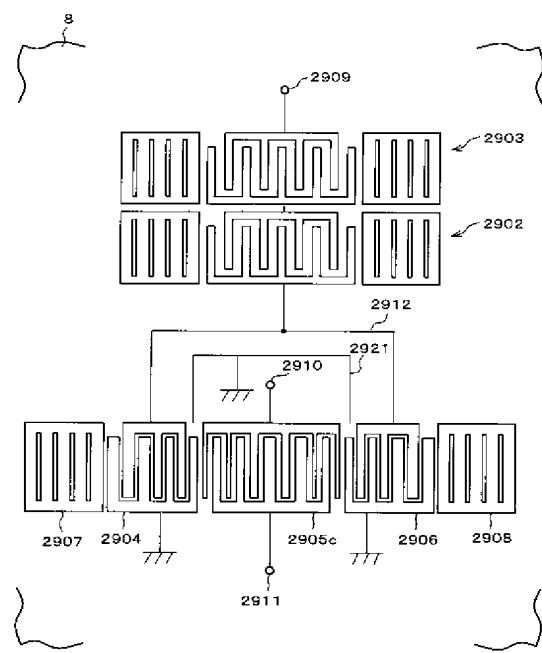
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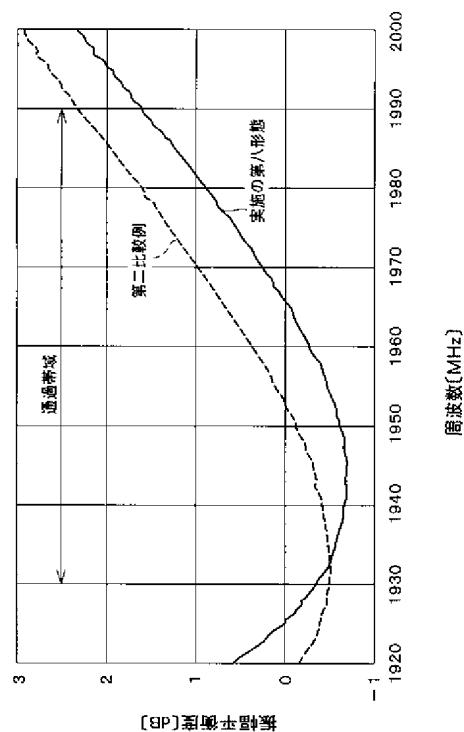
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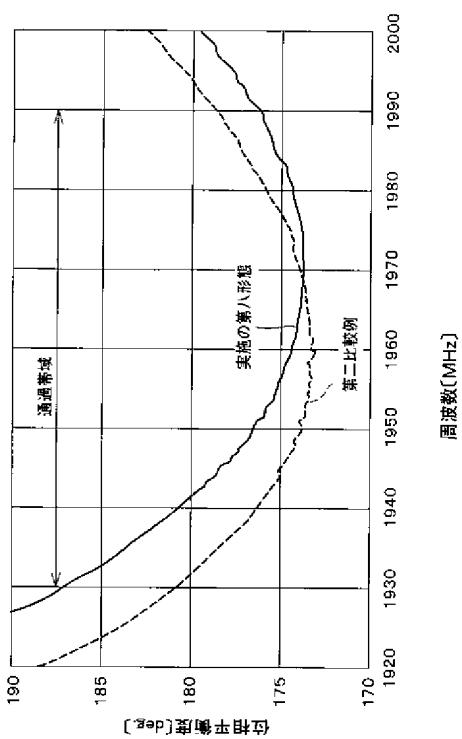
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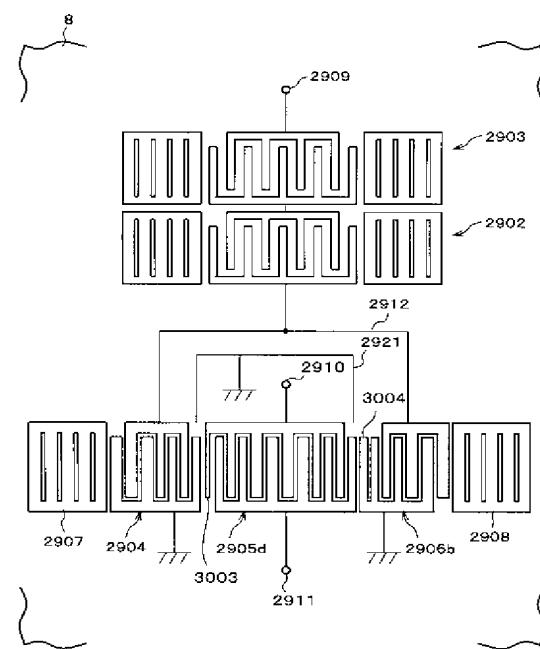
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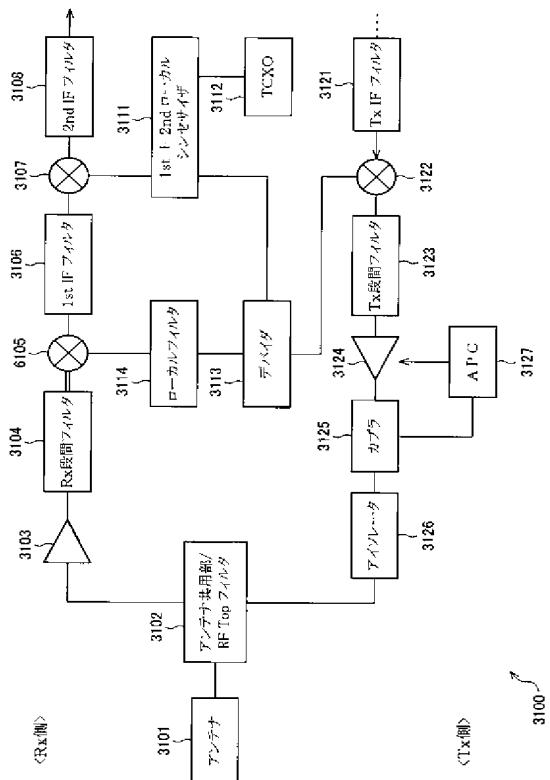
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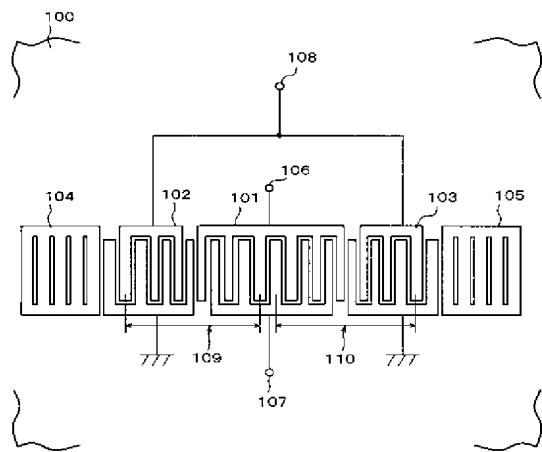
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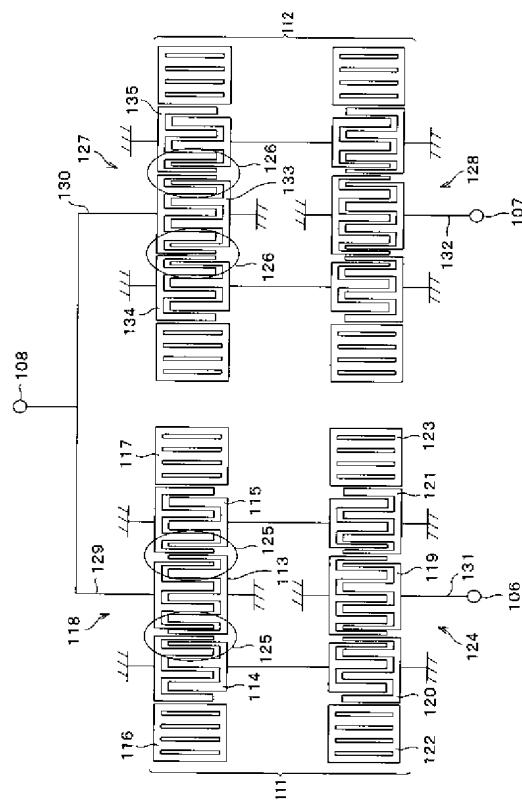
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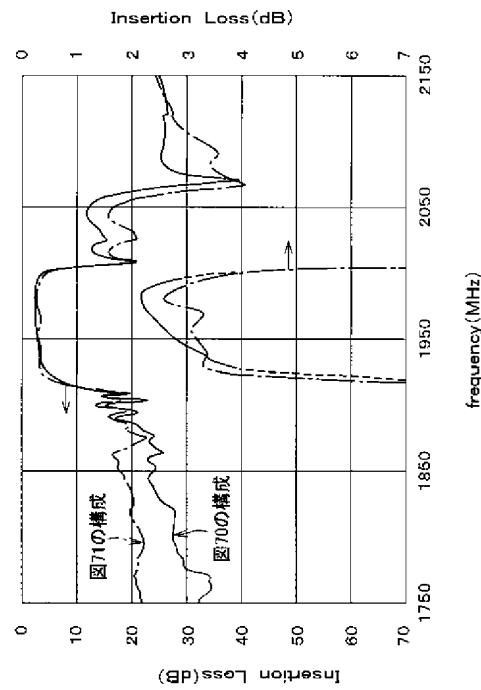
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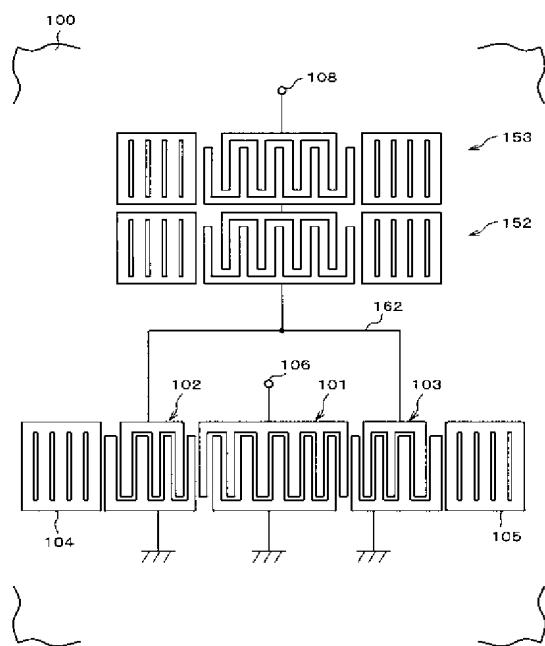
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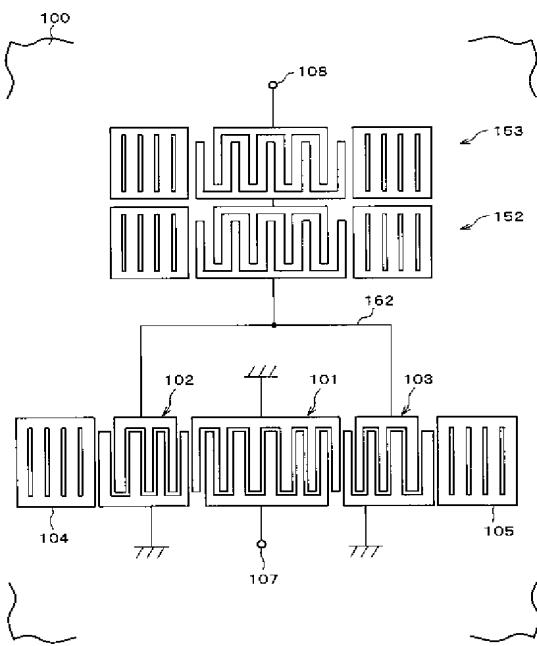
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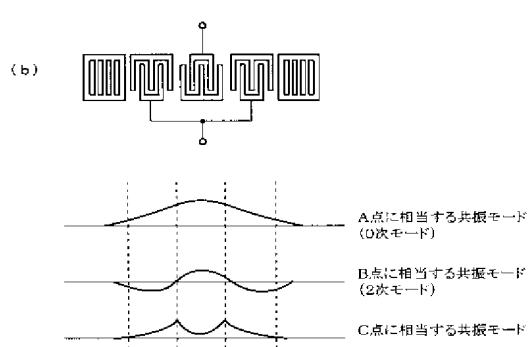
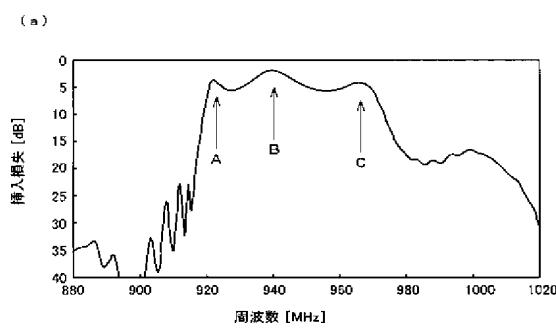
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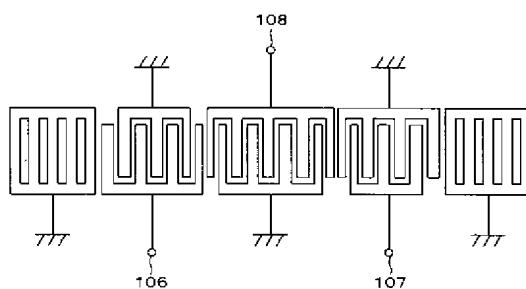
【図 7 1】



【図 7 2】



【図 7 3】



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